

United States v. Pharmacia Corporation (f/k/a Monsanto Company) et al.  
Civil No. 99-63-DRH  
United States District Court for the Southern District of Illinois

EXPERT REPORT:

GROUND-WATER CONTAMINATION  
AT THE  
SAUGET AREA 1 SUPERFUND SITE

EPA Region 5 Records Ctr.



304892

prepared for the  
U.S. Department of Justice  
Environmental Enforcement Section  
Washington, D.C.

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**TABLE OF CONTENTS**

List of Figures.....	v
List of Tables.....	v
List of Appendices.....	vi
List of Acronyms and Abbreviations .....	vi
 1.0 INTRODUCTION.....	 1-1
1.1 Identification of Expert.....	1-1
1.2 Information Relied Upon for Factual Background.....	1-1
1.3 Organization of the Report .....	1-1
 2.0 PREVIOUS STUDIES .....	 2-1
2.1 Village Sewer Studies 1932-1994.....	2-1
2.2 Initial Environmental Investigations—IEPA 1980-81.....	2-1
2.3 Limited Investigations—USEPA 1981-1982 .....	2-2
2.4 Inspections—IEPA 1984.....	2-2
2.5 Monsanto Groundwater Study—Geraghty & Miller 1983-86.....	2-2
2.6 Expanded Site Investigation—E&E 1985-1988 .....	2-2
2.7 G&M Site Investigation at Sites L, M, CS-B 1991-1992.....	2-3
2.8 E & E Data Compilation 1998.....	2-3
2.9 UAO #1 Dead Creek Culvert Upgrade 1999.....	2-4
2.10 UAO #2 Sediment Removals 2000 - 2002.....	2-4
2.11 WGK Current Conditions Report—Solutia 2000 .....	2-4
2.12 EE/CA and RI/FS—Solutia 1999-2001 .....	2-4
 3.0 WASTE DISPOSAL.....	 3-1
3.1 Waste Disposal Areas .....	3-1
3.1.1 Site G.....	3-2
3.1.2 Site H.....	3-5

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

---

3.1.3 Site I.....	3-7
3.1.4 Site L.....	3-9
3.1.5 Site M.....	3-11
3.1.6 Site N.....	3-12
3.2 Dead Creek .....	3-13
3.2.1 Segment A (CS-A) .....	3-13
3.2.2 Segment B (CS-B) .....	3-15
3.2.3 Segments C (CS-C) through F (CS-F) .....	3-17
3.3 Overflowing and Leaking Village Sewers.....	3-17
 4. ENVIRONMENTAL SETTING.....	 4-1
4.1 Surface-water Hydrology .....	4-1
4.2 Geology .....	4-3
4.3 Ground-water Hydrology .....	4-5
4.3.1 Hydrogeologic Concepts and Terminology .....	4-5
4.3.2 Valley Fill Aquifer .....	4-6
4.3.3 Bedrock Aquifer .....	4-11
 5. GROUND-WATER QUALITY .....	 5-1
5.1 Processes of Contaminant Transport to Ground Water .....	5-1
5.1.1 NAPL .....	5-1
5.1.2 Aqueous Liquids .....	5-2
5.1.3 Solids .....	5-2
5.2 Background Ground-Water Quality .....	5-3
5.3 Area 1 Ground-Water Quality .....	5-5
5.3.1 Site G.....	5-6
5.3.2 Site H.....	5-7
5.3.3 Site I.....	5-8
5.3.4 Site L.....	5-8
5.3.5 Site M.....	5-9
5.3.6 Site N.....	5-9
5.3.7 CS-A .....	5-9
5.3.8 CS-B .....	5-10

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

---

6. OPINIONS.....	6-1
6.1 Spatial Distribution of Ground-water Contamination.....	6-1
6.2 Sources of Ground-water Contamination .....	6-4
6.2.1 Land Disposal Sites .....	6-4
6.2.2 Contaminated Surface Water.....	6-8
6.2.3 Leaking Sewers .....	6-12
7. REFERENCES.....	7-1
7.1 Site-Specific.....	7-1
7.2 General.....	7-5



## **List of Figures**

### **2.1 Site Map**

### **2.2 Dead Creek Segments**

**3.1 Waste thickness isopach map (E&E May 1988, Fig. 4-11)**

**3.2 Geologic cross-section locations A-A', B-B', C-C' (E&E May 1988 Fig. 4-8).**

**3.3 Generalized geologic cross-section A-A' (Sites G, H) (E&E May 1988 Fig. 4-9)**

**3.4 Generalized geologic cross-section B-B' (Sites H, I) (E&E May 1988 Fig. 4-10)**

**3.5 Generalized geologic cross-section C-C' (Site L) (E&E May 1988 Fig. 4-11)**

**3.6 Generalized cross section A-A', Dead Creek Sector B and Site L (G&M 1992, Figs. 2-2, 3-1)**

**3.7 Generalized cross section B-B', Dead Creek Sector B and Site M (G&M 1992 Figs. 2-3, 3-2)**

**4.1 Generalized geologic column for unconsolidated deposits to bedrock in the Dead Creek area (IEPA 1981, Fig. 5)**

**4.2 Hypothetical ground water system (American Petroleum Institute 1972, Fig. 2)**

**4.3 Estimated pumpage in East St. Louis-Sauget-Cahokia area, 1890-1980 (G&M 1986, Fig. 4)**

**5.1 LNAPL in the subsurface (National Research Council 2000, Fig. 2-6)**

**5.2 DNAPL in the subsurface (Pankow and Cherry 1996, Fig. 2.5)**

**6.1 Site shadows downgradient of Sites G, H, I, L and M**

**6.2 Chlorobenzene distribution in ground water (maximum over depth)**

**6.3 Chlorobenzene concentrations in groundwater (GSI May 31 2001)**

## **List of Tables**

**3.1 List of chemicals reviewed for potential release to ground water**

**3.2 Waste, soil and ground-water maxima for Site G**

**3.3 Waste, soil and ground-water maxima for Site H**

**3.4 Waste, soil and ground-water maxima for Site I**

**3.5 Waste, soil and ground-water maxima for Site L**

**3.6 Waste, soil and ground-water maxima for Site M**

**3.7 Waste, soil and ground-water maxima for Site N**

**3.8 Waste, soil and ground-water maxima for Site CS-A**

**3.9 Waste, soil and ground-water maxima for Site CS-B**

**3.10 Background Soil Metals Concentrations**

## **List of Appendices**

- Appendix A. Resume of Gary R. Chirlin
- Appendix B. List of Testimony of Gary R. Chirlin
- Appendix C. Publications of Gary R. Chirlin during the previous 10 years
- Appendix D. Compensation of Gary R. Chirlin for this project

## **List of Acronyms and Abbreviations**

AOC	Administrative Order by Consent
bgs	below ground surface
d	day
DCP	Dead Creek Project
DHU	Deep Hydrogeologic Unit
EE/CA	Engineering Evaluation/Cost Analysis
E&E	Ecology & Environment, Inc.
ERI	Environmental Research, Inc.
Fm	(geologic) formation
FSP	Field Sampling Plan
FSR	Field Sampling Report
ft	feet
gpm	gallons per minute
G&M	Geraghty & Miller, Inc.
GSI	Groundwater Services Inc.
IEPA	Illinois Environmental Protection Agency
ISWS	Illinois State Water Survey
m	meters
MHU	Middle Hydrogeologic Unit
MSL	mean sea level
NGVD	National Geodetic Vertical Datum
OBG	O'Brien & Gere Engineers, Inc.
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
SHU	Shallow Hydrogeologic Unit
SSDRA	Sauget Sanitary Development & Research Association
SSP	Support Sampling Plan
UAO	Unilateral Administrative Order
EMSL	Environmental Monitoring Systems Laboratory
US	United States
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
yr	year

## **1.0 INTRODUCTION**

In August 2001 the United States selected Chirlin & Associates, Inc. ("CAI") to provide review and expert testimony concerning the Sauget Area 1 Superfund site located within the towns of Sauget (formerly Monsanto) and Cahokia, Illinois. The designation of "Area 1" follows that of the United States Environmental Protection Agency ("USEPA") and includes five fill areas (Sites G, H, I, L, and N), one former borrow pit (Site M), and five segments of Dead Creek (CS-B through CS-F) (Roux 2001 pg. i). Former creek segment CS-A lies within Site I but is discussed separately in this report.

This report addresses the following issues:

- What hazardous substances have been released to the ground water at the Site;
- where did these hazardous substances enter the ground;
- what is the former and current direction of ground-water flow; and
- what is the current composition and spatial distribution of ground-water contamination?

Area 1 comprises only a portion of a larger land area which contains additional hazardous waste disposal sites and contaminated environmental media. In particular, to the west of Area 1 lies the Sauget Area 2 Superfund Site which includes several known disposal areas. This report addresses only Sauget Area 1.

### **1.1 Identification of Expert**

This report was prepared by Gary R. Chirlin, Ph.D., P.E., principal of Chirlin & Associates, Inc. His resume, testimony provided by Dr. Chirlin as an expert witness during the previous four years or more, publications from the last ten years, and compensation for this project are listed in Appendices A, B, C and D, respectively.

### **1.2 Information Relied Upon for Factual Background**

Documents and other sources of information relied upon in preparation of this report are cited in the text and listed in the Reference List (Section 7) of this report.

### **1.3 Organization of the Report**

Section 2 reviews Site environmental investigations conducted by government and industry; Section 3 describes known Site land disposal areas and other potential sources of ground-water contaminants, including contaminated surface waters and leaking sewers; Section 4 describes Site hydrology, geology and hydrogeology; Section 5 examines the distribution of contaminants in ground water at the Site; and Section 6 interprets these data and draws conclusions.

## **2.0 PREVIOUS STUDIES**

The Village of Sauget, the Illinois Environmental Protection Agency ("IEPA"), the USEPA, their contractors, and Defendants and their contractors conducted investigations of the Site during the 1960s, 1980s, 1990s, and early 2000s. This section briefly describes field investigation activities of these studies. Figures 2.1 and 2.2 show industrial properties, roads, and named waste areas and creek segments within and near to Sauget Area 1.

### **2.1 Village Sewer Studies 1932-1994**

It is my understanding that the report by Mr. Mark Klingenstein, an expert witness for the US in this litigation, includes a review of Village sewer studies.

### **2.2 Initial Environmental Investigations—IEPA 1980-81**

In July 1979 and again in May 1980 the Illinois Environmental Protection Agency (IEPA) received complaints concerning a site in Cahokia that contained randomly dumped, periodically smoldering materials in a ditch (Dead Creek). When in August 1980 a neighborhood resident's dog rolled in Dead Creek and died apparently due to chemical burns, it became clear to IEPA that further investigation was required. (IEPA 1981 pg. 1; E&E May 1988 pg. 2-56).

During September through November 1980 IEPA performed

- (1) Dead Creek sediment and water sampling in all creek segments, and
- (2) qualitative air sampling in CS-B (E&E May 1988 pp. 2-57 and 2-58).

Between October 1980-April 1981 the Ground Water Management Section of the Division of Land/Noise Pollution Control of IEPA conducted a study, authored by Ron St. John, "to determine the hydrogeologic framework at Dead Creek and to discuss possible disposal sites and their impact on ground water, surface water, soil and plants in the area" (IEPA 1981 pg. 1). Although some data were collected elsewhere, the study area was defined as a rectangle covering most of the land between Queeny Ave., Judith Lane, Route 3 and Falling Springs Road, thus encompassing Segment B of Dead Creek and Sites G, H, L, and M. Site I also is discussed.<sup>1</sup>

The study included review of IEPA files and geologic and hydrogeologic literature. Waste disposal activities and areas were investigated using historical records, interviews of local residents, stereo viewing of aerial photographs from 1937, 1940, 1950, 1955 and 1962, review of a 1973 US Army Corps of Engineers map, and a December 1980 thermal infrared survey (multispectral scanner data and color infrared photographs) by Environmental Monitoring Systems Laboratory ("EMSL")<sup>2</sup>. Field activities included

- (1) five hand auger borings in the creek bottom,
- (2) soil samples (for physical and chemical analysis),
- (3) twelve test holes completed with monitoring wells (G101 through G112),

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<sup>1</sup> The Area 1 lettered Sites are described in Section 3.1.

<sup>2</sup> EMSL was a USEPA contractor specializing in photographic interpretation. USEPA Region V requested this analysis.

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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(4) occasional ground-water elevation measurements, and  
(5) ground-water samples from monitoring wells and private wells.  
Geophysical surveys including a metal detection survey and a seismic survey were attempted but proved uninformative. (IEPA 1981 pp. 1, 2, 6, 12, and Fig. 1).

### ***2.3 Limited Investigations—USEPA 1981-1982***

In September 1981 USEPA formed a Sauget task force to investigate past and present waste disposal activities in the Sauget vicinity. "Limited investigations and interviews" were conducted at Sauget area industries (E&E May 1988 pg. 2-59).

In March 1982 USEPA or its contractor collected several environmental samples including (E&E May 1988 pg. 2-60)

- (1) private well and garden soil samples at residences in the Dead creek area,
- (2) sediments in CS-A,
- (3) ground water from a well at Cerro Copper, and
- (4) air samples at CS-B.

### ***2.4 Inspections—IEPA 1984***

In October 1984 IEPA conducted inspections at Site G and CS-B in order to determine the scope of proposed cleanup, and collected three samples (WS-1, 2, 3) of oily pits at Site G (E&E May 1988, pg. 2-63).

### ***2.5 Monsanto Groundwater Study—Geraghty & Miller 1983-86***

In 1983 Monsanto retained Geraghty & Miller, Inc. ("G&M") to perform hydrogeologic investigations at the WGK facility and Site R (then known as the Monsanto Landfill). These facilities are not within Area 1, but the WGK plant study does provide information of interest here. The work is described in G&M (1986); its purpose was "to determine the direction and rate of ground-water flow and to characterize ground-water quality" (G&M 1986, pg. 1). During field activities at the WGK plant G&M

- (1) performed soil borings,
- (2) installed over 40 monitoring wells (GM-#),
- (3) periodically sampled the monitoring wells, certain dewatering wells, and two offsite wells (WB-6, WB-7),
- (4) slug-tested three wells for shallow hydraulic conductivity, and
- (5) measured ground-water elevation.

G&M delineated source areas at WGK, discussed historical and contemporaneous ground-water flow patterns and velocities, identified and quantified ground-water contaminants (including both priority pollutant list and library-search compounds) and inferred migration routes of ground-water contamination. (G&M 1986 Vol. 1, Table 11, Vol. 2 pp. 2-3; E&E May 1988 pp. 2-71 to 2-72).

### ***2.6 Expanded Site Investigation—E&E 1985-1988***

Between July 1985 and May 1988 IEPA contractor Ecology & Environment, Inc. ("E&E") conducted an expanded site investigation of the so-called Dead Creek Project ("DCP") sites. E&E defined DCP Area 1 to include four suspected waste disposal sites (G, H, I and L) and Dead Creek sectors A and B; DCP Area 2 to include three suspected waste

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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disposal areas (O, Q and R); and the DCP Peripheral Sites to include five suspected waste disposal sites (J, K, M, N, and P) and Dead Creek segments C through F. These three "Area" definitions are superseded in subsequent documents.

Field activities for the E&E expanded site investigation occurred during October and December 1985 (surface geophysics only) and November 1986 through July 1987. They included:

- (1) surface geophysics, including magnetometry to locate buried ferrous materials such as drums, and electromagnetic ["EM"] induction surveys to characterize subsurface materials and identify contaminant plumes;
- (2) soil gas surveys at 85 Area 1 stations to identify significantly contaminated areas, delineate boundaries of former excavations, and determine contaminant migration routes;
- (3) surface soil samples at 76 stations (41 analyzed after screening) in Site G and two in Site J to characterize waste types and overall extent of surface contamination;
- (4) thirteen surface water samples and 33 sediment samples from Dead Creek segments CS-A through CS-D;
- (5) subsurface borings at 71 stations, many within waste sites, all logged and sampled for chemical analysis;
- (6) groundwater-related activities including installation of 35 shallow ground-water monitoring wells (EE-#, EE-G#), hydraulic conductivity slug tests at 15 of the wells, water level measurements on three dates in 1987, and 56 ground-water samples from new and existing monitoring wells and private wells; and
- (7) air samples at six locations near the creek and six locations adjacent to the Mississippi River. (E&E May 1988 pp. 1 through 3, Sect. 3).

E&E (May 1988) describes historical disposal activities; local ground-water supply usage; waste area features inferred from magnetometry, borings, and soil gas; historical and contemporaneous ground-water flow properties; and surface-water, sediment, and ground-water contaminant concentrations and distributions.

### ***2.7 G&M Site Investigation at Sites L, M, CS-B 1991-1992***

Monsanto retained G&M to characterize sites L, M and CS-B by determining the nature and extent of sediment/fill materials and estimating the volume of materials affected by organic or metal contaminants. Field work during this effort included collection and targeted chemical analyses of sediment samples from 30 borings along 10 transects in CS-B, six borings in Site L, and 10 borings in Site M. The G&M field team was not given permission to enter the upstream 450 feet of CS-B, which is adjacent to Site G. (G&M 1992, Sect. 2.3).

### ***2.8 E & E Data Compilation 1998***

At the request of the USEPA, E&E compiled and summarized existing technical data for the sites in Sauget Area 1 and Sauget Area 2. The work was conducted to support enforcement, cleanup oversight, and cost recovery efforts (E&E 1998 pg. 1-1). For each Site the summary document includes a site description, a site narrative listing known sampling events with a brief characterization of contamination, and maps and data tables. The Area 1 report addresses the following Sites: G; H; L; I and CS-A; M and CS-B; N and CS-C; CS-D and CS-E; CS-F; and "Area 1 Groundwater."

### **2.9 UAO #1 Dead Creek Culvert Upgrade 1999**

A Unilateral Administrative Order ("UAO") was issued by USEPA to Solutia, Inc.<sup>3</sup> on June 21, 1999. The UAO requires replacement of selected culverts along Dead Creek in order to improve hydraulic efficiencies (Roux 2001, pg. ii). Agreement was reached to replace only the culverts at Cargill Road and at the Terminal Railroad Embankment; both are located along creek segment CS-F. That work is complete (Solutia 2002 pg. 1-11).

### **2.10 UAO #2 Sediment Removals 2000 - 2002**

A second UAO was issued by USEPA to Solutia, Inc. on May 31, 2000. This UAO "requires the removal of affected sediments from Dead Creek Segments CS-B, C, D, E, a portion of F, and Site M, and subsequent placement in a containment cell to be constructed adjacent to CS-B." The UAO was amended to include appropriate response actions for the remainder of CS-F and Borrow Pit Lake. It is intended that these removal actions effectively eliminate identified sediment transport and exposure pathways at Dead Creek. (Roux 2001, pg. ii). A Time Critical Removal Action Work Plan was submitted to the USEPA on June 30, 2000, and installation of a sediment dewatering system began in November 2000. Confirmatory sediment sampling was conducted to determine when sufficient material was removed. A liner was placed over portions of the excavated creek bed. A risk evaluation was conducted by Solutia at the conclusion of the sediment removal to characterize risk to human health and the environment (Solutia 2002).

### **2.11 WGK Current Conditions Report—Solutia 2000**

In response to an Administrative Order ("AO"), Solutia prepared a report summarizing the nature and extent of hazardous substances released from the Monsanto (now Solutia) William G. Krummrich ("WGK") facility, including interpreted ground-water contaminant plume diagrams. The study also contains summaries of historic operations and reported post-1981 spills at the plant, of compounds detected in ground waters at the plant, and of recent ground-water and soil sampling results. For nearby facilities historical activities, wastes released to soil, ground water, and sewers, and soil and ground-water quality are described, including at three industries upgradient of Area 1 (Sterling Steel, Mobil, T.J. Moss). A sampling plan is proposed to meet two additional requirements of the AO: an evaluation of the stability of contaminated ground-water migration from WGK and analyses of risks posed by releases. (Solutia March 2000). WGK lies outside of Area 1, but the report provides information useful to this report, including appendices containing site-wide data and reports.

### **2.12 EE/CA and RI/FS—Solutia 1999-2001**

During 1999-2001 Solutia, Inc. performed a combined Engineering Evaluation/Cost Analysis—Remedial Investigation/Feasibility Study ("EE/CA—RI/FS") for Area 1. The EE/CA addresses removal action selection for affected soils, sediments, surface water and air; the RI/FS addresses remedial action selection for affected ground water. Site characterization activities of the two studies were merged into a single work plan referred to as the Support Sampling Plan ("SSP"). The environmental data collection

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<sup>3</sup> Solutia Inc. was created when Monsanto spun off its chemical businesses in 1997.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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effort underlying the EE/CA—RI/FS is documented by the SSP (Solutia June 1999)<sup>4</sup>, a Field Sampling Report ("FSR"; OBG September 2000), a Support Sampling Plan Data Report (Solutia January 2001), and a data validation report (OBG August 2000).

Principal investigative and assessment components of the EE/CA—RI/FS addressed delineation of source area boundaries, characterization of aquifer parameters, delineation of constituents of potential concern ("COPC") in soil, sediment and ground water and evaluation of the potential presence of COPCs in surface water and air, and leachate pilot treatability studies<sup>5</sup>. These results were used in turn to complete human health and ecological risk assessments<sup>6</sup> and to prepare the EE/CA and RI/FS reports. (Roux 2001, pp. ii-iii).

More specifically, field activities of the SSP included

- (1) viewing aerial photographs, performing elevation surveys at the sites, reviewing topographic maps;
- (2) boundary test trenches to better delineate fill areas;
- (3) soil gas surveys;
- (4) waste sampling;
- (5) magnetometer survey;
- (6) buried drum and tank identification;
- (7) ground-water sampling<sup>7</sup> for cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs;
- (8) aquifer (slug) testing;
- (9) soil sampling in areas subject to flooding or deposition of windblown dust;
- (10) soil sampling for grain-size analysis;
- (11) sediment sampling;
- (12) surface water sampling; and
- (13) air sampling (Roux 2001 Sect. 3).

The EE/CA—RI/FS does not attempt to establish the origin of contaminants at industrial facilities within or adjacent to the Site: "Characterization of sources at industrial facilities and characterization of the extent of migration from these sources through the soil, surface water, sediment, ground water or air pathways was not included in the scope of the AOC" (Roux 2001 pg. 1-1). However, section 5 of the EE/CA—RI/FS does address the source, nature and extent of contamination from specific lettered waste disposal sites within Area 1.

The EE/CA identifies four alternative fill area removal actions, and the focused feasibility study identifies two alternative ground-water remedies. The final Site response action has not yet been selected. It may be one of the combined alternatives or may contain a

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<sup>4</sup> The Solutia SSP includes a Field Sampling Plan ("FSP"; OBG June 1999), Quality Assurance Project Plan ("QAPP"; OBG August 1999), and Health and Safety Plan (OBG June 1999b).

<sup>5</sup> Planned waste treatability studies proved to be infeasible (Roux 2001 Appendix A).

<sup>6</sup> Creek Segments B, C, D, E, and F, as well as Site M, were excluded from the two risk assessments because these sources are to be eliminated by the UAO #2 sediment removal action (Roux 2001 pg. iv).

<sup>7</sup> Most samples were collected from existing monitoring wells. However, for wells that no longer existed or could not be sampled, the EE/CA—RI/FS collected samples by advancing a Geoprobe and obtaining a ground-water sample from the appropriate depth interval (Roux 2001 pg. 3-10).



## ***Sauget Area 1 -- Expert Report on Ground Water Contamination***

---

different mix of the component actions identified in the EE/CA—RI/FS. Regardless of the selected remedy, restoration of ground-water quality is expected to take several hundred years. (Roux 2001 pg. vi).

### **3.0 WASTE DISPOSAL**

#### **3.1 Waste Disposal Areas**

Area 1 contains several waste disposal sites which have been named alphabetically. These include three closed landfills (Sites G, H and I), two backfilled former surface impoundments (both comprising Site L), one inundated former borrow pit (Site M) and one backfilled borrow pit filled principally with construction debris (Site N) (Roux 2001 Sect. 5.2). Area 1 also contains almost the entirety of historical Dead Creek, and all of its current channel, including from the Alton & Southern RR tracks to the mouth at Prairie du Pont Creek. Most of the waste disposal areas at the Site initially were identified by IEPA. To that end IEPA relied in substantial part on examination of historical aerial photographs. However, by the date of the earliest available aerial photograph, taken in 1937, the Sauget area already was significantly industrialized. IEPA contractor E&E deemed it probable that uncharacterized industrial waste disposal activity predated the first photograph. (E&E May 1988, pg. 2-42).

The following sections describe evidence of site- and creek segment-specific waste disposal at the lettered Area 1 Sites. These descriptions are drawn from reported findings of IEPA, E&E, G&M, Roux/Solutia, and Environmental Research, Inc. ("ERI") and are based on historical information, interpretation of aerial photographs, and some of the field investigations described in Section 2. Aerial photographs from the following years were used by IEPA and E&E to interpret disposal activities: 1937, 1940, 1950, 1955, 1962, 1973, 1978, and 1985 (IEPA 1981, E&E May 1988). Aerial photographs from the following years were used by ERI (2002) to interpret disposal activities: 1937, 1940, 1943, 1945, 1947, 1948, 1950, 1953, 1955, 1960, 1962, 1967, 1968, 1971, 1973, 1974, 1975, 1977, 1978, 1979, 1982, 1985, 1988, 1993, 1998 (ERI 2002 pg. 8, Table 2). Not all Sites are covered by every photo. Historical information was obtained principally from Roux (2001, Sect. 2.2), much of which is repeated in Solutia (2002, Sect. 2.1). Most of the Area 1 waste and soils chemical data were collected during the E&E (May 1988), G&M (1992), and Roux (2001) field investigations; E&E (1998) provides a tabulation through its publication date, and OBG (August 2000) and Solutia (January 2001) report the EE/CA—RI/FS field data.

*Set of reviewed chemicals.* For the purposes of this report the United States provided me with a set of chemicals to be reviewed. I have reduced the US's list by five chemicals<sup>8</sup> which were not analyzed during the EE/CA—RI/FS. I have not further considered three chemicals<sup>9</sup> that were not detected in any ground-water sample during the EE/CA—RI/FS. Finally, I have added 14 chemicals which occurred repeatedly in ground-water samples<sup>10</sup>. The 60 analytes in this set are listed in Table 3.1; in this report I

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<sup>8</sup> benzyl chloride, 2-chloroaniline, 4-chlorophenol, 1,2,4,5-tetrachlorobenzene, 1,2,3,4-tetrachlorobenzene

<sup>9</sup> 3-nitroaniline, 2-nitrophenol, 4-nitrophenol

<sup>10</sup> 2-chlorophenol, 4-chloroaniline, PCBs, chloroform, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, carbazole, benzo(k)fluoranthene, 1,2-dichloroethene, MCPP, molybdenum, tetrachloroethene, trichloroethene, vinyl chloride

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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refer to them as the “chemicals of interest” (and “VOCs of interest”, “metals of interest”, etc.).

*A note on background metals concentrations.* In general the organic compounds reported in Site samples are not naturally occurring and therefore represent releases to the environment. On the other hand, the metals reported in wastes, soils and sediments also are naturally occurring to some degree. Therefore background concentrations are required to determine whether observed concentrations are elevated. In order to establish background concentrations of heavy metals for soils and sediment samples, E&E (May 1988, pp. 3-19, 3-34, 4-102, 4-112) and Solutia (2001, pg. 3-19; data at Solutia January 2001 Tables 2-6, 3-6) use selected local samples. Conversely, G&M (1992) uses values typical of pedalfers (a soil type common to humid regions) as reported by a US Geological Survey (“USGS”) study. G&M does not use local samples for background data because “it is suspected that all of Dead Creek may have been affected by past activities in the area” (G&M 1992 pg. 4-2). In this report I use the local samples selected by E&E and the EE/CA—RI/FS to establish background soil/sediment quality. To the extent that those samples contain anthropogenic metals, my approach tends to err on the side of underestimating releases from the Area 1 Sites. A summary of those data for the metals of interest is provided in Table 3.10.

### **3.1.1 Site G**

Site G is a former surface and subsurface disposal area which occupies about five acres. The approximate boundary of Site G is shown in Solutia (2001 Fig. 3-1). The Site extends from Dead Creek segment CS-B on the east to approximately the midline of the Wiese Engineering building on the west, and from Queeny Avenue on the north to a field on the south. The earliest excavation at Site G is visible in 1950, and disposal first becomes evident in the 1953 photo.

Investigators differ somewhat on the date of last disposal of industrial wastes at Site G. Roux (2001, pg. 2-2) states that activities halted in 1966; E&E (May 1988 pp. 2-48, G-1) specifies some time between 1962-1973; E&E (1998, pg. US06872 excerpted from an IEPA site screening document) places activity into the late 1970's; and ERI (2002 pp. 5, 10) reports activity through at least 1982. These apparent inconsistencies may reflect different interpretations of “active disposal” (e.g., into excavated pits vs. dumping of debris). In October 1980 IEPA sampled subsurface soils and installed monitoring wells at Site G (IEPA 1981). Site G was subject to intermittent dumping from the end of active disposal until it was fenced for the first time in May 1987 (E&E May 1988 pg. G-1; Solutia 2001 pg. 2-2).

Aerial photographic interpreters report the following for Site G. No excavation is yet apparent at Site G in 1940 or 1945. A relatively small pit with liquid exists in 1950. Excavations with medium-toned and dark-toned liquids are evident beginning in 1953. In 1955 multi-toned material and debris are seen in a southern excavation, and in 1960 such materials and debris are evident across the site. In 1973 the new Wiese Engineering building is seen along the west side of Site G where previous photos indicated disposal activity. E&E (May 1988 pg. 2-48) infers that active disposal appears to have ended by the 1973 photo, and that conditions in the 1978 and 1985 photos are similar to those encountered during 1981 and 1985-1987 IEPA field work. ERI (2002 pp. 5, 10) reports various-toned material and liquids and debris in the eastern portion of the

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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site through 1982 and graded medium-toned material in western Site G in 1979, both indicative of disposal activities. (E&E May 1988, pp. 2-5, 2-42, 2-45, 2-48, 2-51, G-1; ERI 2002 pp. 10-11). With respect to the SW corner of Site G, aerial photographs do not indicate any excavation or any disposal other than of surficial debris (M. Sitton, pers. comm. 10/7/02).

In 1986 the surface of Site G was observed by IEPA contractor E&E to be littered with demolition debris and metal wastes. Two small pits in the northeast and east-central portions exhibited oily and tar-like wastes and scattered corroded drums. Twenty to thirty deteriorated drums were scattered along an east-west ridge near the south end of the site; several additional corroded drums protruded from a mounded area in the western portion of the site; and a large depression just south of the mound received runoff from a sizeable portion of the site. Fly ash and cinder material partially covered the site. Wastes located on the surface and/or in the subsurface of Site G spontaneously combusted and/or burned for long periods of time on several occasions. In May 1987 after high levels of organic contamination were detected in surface soils, Monsanto constructed a chain-link fence around the site under USEPA supervision as a CERCLA removal action.<sup>11</sup> (E&E May 1988 pp. 2-5, 2-41, 2-65, G-1, Figs. 4-1, G-1, Sect. 4.2.3; Roux 2001 pg. 2-2).

A magnetometer survey in December 1985 showed a major anomaly beneath most of the northern portion of Site G. Several smaller anomalies were found to the north of the large depression in the southwest corner of Site G. The mounds in the NW corner of the site showed smaller anomalies at the surface and larger anomalies for deeper readings, indicating significant quantities of buried metals. An electromagnetic ("EM") survey also was performed using both shallow and deep (approximately 10-15 m) soundings. The shallow soundings detected anomalies in the NE corner, the east-center, and the entire west mound areas. The deep soundings found anomalies within most of the northern portion of the site, possibly within the center, and also trending offsite to the northwest. However, based on the absence of waste in two borings E&E concluded that the pit in the NW probably does not extend beneath Queeny Ave. (E&E May 1988, pp. 4-1 through 4-5, 4-19, Fig. 4-1, G-5, G-7).

Boring logs at Site G revealed 3 to 12 feet of fill which increased in thickness from east to west. This surficial material generally consists of very sandy silty clay mixed with cinders, slag, and occasional gravel. The fill covers wastes which apparently were deposited in the old sand pit that is visible in historical aerial photographs. A boring (G9 in the NW part of Site G) in the deepest part of the pit encountered 25 ft of black oily sludge, refuse and unknown wastes. Elsewhere waste thickness averages about 16 ft, most of it lying beneath the water table which is approximately 11 ft below ground surface ("bgs"). Waste thickness was 18 ft in one boring (G8) less than 50 ft from Dead Creek CS-B. The base of the pit, and of the wastes, generally lies in silty fine sand deposits near the bottom of the Cahokia Alluvium.<sup>12</sup> These sands are extensively stained below the pit. Figure 3.1, Figure 3.2, and Figure 3.3 illustrate the interpreted waste thickness and depth and the water table at Site G. (E&E May 1988 Table 3-5, pp. 4-13 to 4-19, 7-11; E&E 1998 pg. US06871).

<sup>11</sup> Roux (2001, pg. 2-2) places fence construction in May 1988, but ERI (2002, pp. 11, 44) reports the fence present in February 1988.

<sup>12</sup> Geologic units at the site are described in Section 4.2.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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The deepest elevation of the base of the NW pit, approximately 373 ft MSL (Figure 3.3), generally corresponds to the lowest estimated water table elevation during the period of active disposal. This suggests that the pit was excavated until ground water was encountered. (A similar conclusion may be drawn for the pits in Sites H and I). (Section 4.3.2; E&E May 1988 pg. 4-46).

Site G underwent a second CERCLA removal action in 1995. This action involved the excavation of PCB-, organics-, metals-, and dioxin-contaminated soils on and surrounding Site G, solidification of open oil pits on the site, and covering part of the site including the excavated contaminated soils with a clean soil cap approximately 18 to 24-inches thick. Waste removal extended to the foundation of the adjacent Wiese Engineering building which is west of the fenced area. Because of the wastes encountered in this area, Area G is now defined to extend beyond the fence and beneath the Wiese Engineering building, notwithstanding some drawings to the contrary (USEPA 2001, comment 4; Roux 2001, pg. 2.2, Fig. 3-1). The 1995 removal action also installed a security fence around the site (excluding the Wiese property). (Roux 2001 pg. 2-2, Sect. 2.3.3).

EE/CA—RI/FS Site G characterization borings encountered oily wastes and an unidentified yellow substance. PID<sup>13</sup> readings of waste samples from borings reached a maximum of 1367 ppm. (OBG Sep 2000 Vol. 1 part 2 pp. 33-41).<sup>14</sup> Test trenching during the EE/CA—RI/FS exposed drums and drum fragments, some containing waste materials. Pyrophoric materials were indicated by smoke from one drum. A yellow-green material covered some rocks at the water table. (OBG Sep 2000 Vol. 8 part 2 pp. 58-63).

Site G has been tested for total and leachable (TCLP) hazardous substances. Wastes and soils within Site G were sampled by IEPA in 1980, 1984, and 1994, by E&E and Weston in 1986-87, by G&M in 1991, and by Solutia in 1999 (IEPA 1981; E&E May 1988 Sects. 3.6.1, 4.2.3, 4.2.4, Tables 4-10, 4-11, pp. G-1 to G-8; E&E 1998; OBG August 30 2000). These data indicate that Site G wastes and soils are highly contaminated with a variety of hazardous substances. Table 3.2 lists maximum detected concentrations of the chemicals of interest. Benzene, chlorinated benzenes, 2,4,6-trichlorophenol, pentachlorophenol, naphthalene, 2,4-D, PCBs, chromium, lead, mercury, vanadium and zinc are particularly elevated. Sample G8-70 collected in 1987 contained 1% organic chemicals by weight (E&E May 1988 pg. 4-130).<sup>15</sup>

It is noted that the compositing method used to collect subsurface soil samples in the E&E May 1988 study (E&E May 1988 Sect. 3.6.1) may have lost VOCs to the air, and therefore the respective reported VOC concentrations in Table 3.2 may be biased low or

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<sup>13</sup> A PID, or photo-ionization detector, is a hand-held device which is sensitive to volatile organic compounds and often is used to screen samples for VOC contamination.

<sup>14</sup> OBG (Sep 2000), the EE/CA—RI/FS Field Sampling Report, was provided to me as 13 pdf digital files. Pagination is lacking or cut off at the edges of the images. To facilitate finding cited documents, I list the page numbers as they appear in Acrobat Reader (which generally would not match the page numbers on the paper documents).

<sup>15</sup> A 1% concentration equals 10,000 mg/kg.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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may be falsely not-detected.<sup>16</sup> In addition, the very high concentrations encountered in Site G samples often necessitated high dilutions (up to 1:1000) by the laboratory, and this causes loss of detection of compounds present at lesser but still significant concentrations (E&E May 1988 pg. 4-103).

### **3.1.2 Site H**

Site H is a former subsurface disposal area covering approximately five acres in Sauget south of Queeny Avenue and west of Falling Spring Road. The boundary of Site H is shown in Roux (2001 Fig. 3-2). The southern boundary of Site H has not been precisely delineated, but is estimated to be approximately 1,250 ft south of Queeny Ave. (Roux 2001 pg. 2-2). Disposal activities at Site H began in the early or mid 1940s. Investigators differ on the date of last disposal of industrial wastes to the Site. Monsanto has reported that disposal ended in 1957, although that date referred jointly to Sites H and I (E&E May 1988 pg. H-1). E&E (May 1988 pg. 2-48) inferred that the pit was filled and disposal activity ceased by 1955. ERI (2002 pp. 5, 12) describes evidence of disposal within excavated areas until 1960, and debris and multi-toned material on the surface of the excavated areas through 1982. The southern half of Site I operated contiguously with Site H and they are jointly referred to by Monsanto as the Sauget-Monsanto Landfill.

Aerial photographic interpreters indicate the following for Site H. Excavation is evident at northern Site H and southern Site I in the earliest aerial photo in 1937, which suggests that the site initially operated as a sand and gravel borrow pit occupying that area. Excavation continues in 1940. Liquid fills the excavation in 1943 but concurrent flooding precludes inferences on disposal. In 1945 disposal is evident along the eastern perimeter and NW corner; liquid fills the remainder of the excavation; and flooding is evident. From 1947 through at least 1953 significant disposal activities are ongoing, progressing east to west within the site and in the NW corner. The majority of Site H is filled by 1950, the exception being a small area in the NW corner which is filled by 1955. The construction of new Queeny Ave. in 1950 (E&E May 1988, pg. 2-45; ERI 2002 pg. 11) bisects the original excavated area and now defines the boundary between Sites H and I. ERI (2002 pg. 12) points out site changes after 1953. Multi-toned material and debris are present in 1955, mounded material has been deposited as of 1962, and more mounded material and probable debris appear in 1967. Beginning in March 1968 graded material and probable dredge material are present. By September 1968 much of the material appears to have been graded, and a trench is located along the SE border. In 1971 two trenches are evident in the southern portion of the site. Medium-toned material is onsite in 1973 and 1974, and tank trucks, tank trailers and trailers apparently associated with Site L are parked on the southern portion of Site H in 1974. A pit with liquid appears in the 1975 photo and remains visible through 1979; light and medium-toned material is added in and around the pit in 1978. Liquid and multi-colored material are visible in 1982. ERI did not discern any disposal activities in or after 1985.

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<sup>16</sup> Recognizing this potential bias, the EE/CA—RI/FS did not composite Site soil samples intended for VOCs analysis (OBG Sep 2000 Vol. 1 part 2 pg. 3). However, only TCLP analyses were performed on these samples. The TCLP suite of parameters is limited and does not include many of the chemicals present in Area 1 wastes. In addition, compositing is by its nature an averaging procedure which therefore obscures maxima.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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Monsanto has reported to USEPA that subsurface disposal of organics, inorganics, and solvents in drums occurred at the Sauget-Monsanto Landfill from an unknown beginning date (E&E 1998 pg. US06875 and Roux 2001 pg. 2-3 estimate 1931) until 1957. The site received chemical wastes from the Monsanto Queeny (St. Louis) and W. G. Krummrich (Sauget) plants (E&E 1998 pg. US06875). Chemical wastes disposed at the Sauget-Monsanto Landfill include drums of solvents, other organics and inorganics, including PCBs, 4-nitroaniline, chlorine, phosphorus pentasulfide, and hydrofluosilic acid. Municipal wastes also reportedly were disposed at the Landfill. (Solutia 2002 pg. 2-20; Roux 2001, pg. 2-3; E&E May 1988, pp. 2-45, H-1, IA-1; IEPA 1981, pg. 6, Fig. 3c).

A geophysical survey of Site H detected three large areas with major magnetic anomalies and two smaller localized areas with lower intensity anomalies. All anomalies are of sufficient magnitude to indicate buried drums or a large amount of other buried ferrous metal, and the anomalous areas are part of one large fill or disposal pit. An EM survey using shallow (0-7.5 m), intermediate (5-15 m) and deep (12-30 m) effective range detected shallow and intermediate depth anomalies that correspond to the magnetometer survey results. The absence of deep anomalies suggests that disposal generally did not exceed 15 m (46 ft) bgs. (E&E May 1988 pg. H-2; Fig. H-1).

Borings from Site H reveal 2.5 ft (just outside of the pit) to 13 ft of fill consisting of silty clay mixed with crushed limestone, bricks and cinders. Visibly contaminated waste materials are found beneath the fill, including multicolored sludges, solids, chemical wastes, and oily refuse. The waste is up to 20 ft thick, with an estimated maximum depth of 26 ft bgs. The base of the pit and of the waste occurs in the bottom of the Cahokia Alluvium and/or the top of the Henry Fm., and sands and silts as much as 10 ft below the waste are visibly stained. Most of the waste lies below the water table which averages 10 ft bgs. Figure 3.2, Figure 3.3, and Figure 3.4 show the interpreted waste thickness and depth and the water table at Site H. (E&E May 1988 Table 3-5, pp. 4-19, 4-20, 7-11, Fig. 4-11; E&E 1998 pg. US06875).

A variety of fill materials, but no specific uncontained waste materials, were encountered in the EE/CA—RI/FS Site H characterization borings. Maximum PID reading was 2000 ppm. (OBG Sep 2000 Vol. 1 part 2 pp. 42-49). Trenching during the EE/CA—RI/FS revealed drums and drum fragments, at least one of which contained waste solids. Also encountered were bricks, wood, metal and other refuse. (OBG Sep 2000 Vol. 8 part 2 pp. 63-67).

When inspected in 1985 or 1986 no waste material was evident on the surface of Site H, which had been covered, graded, and vegetated. At that time several areas of depression existed within the open field which were capable of retaining runoff (E&E May 1988 pp. 2-5, 4-3, 4-6, 4-7, 4-8 through 4-10, H-1). Exposed slag currently persists at grade. Access to Site H is not restricted. (Roux 2001 pg. 2-3).

Site H has been tested for total and leachable (TLCP) waste constituents. Wastes and soils within Site H were sampled by E&E in 1986-87 and by Solutia in 1999 (E&E May 1988 Sect. 3.6.1, 4.2.4; OBG August 30 2000). Table 3.3 lists maximum detected concentrations of the chemicals of interest. These data indicate that Site H wastes and soils are contaminated with a variety of hazardous substances. Chlorinated benzenes, 4-nitroaniline, phenanthrene, PCBs, lead, nickel and zinc are particularly elevated. Sample

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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H4-19 collected in 1987 contained 2% organic contaminants by weight (E&E May 1988 pg. 4-130). Studies prior to the EE/CA—RI/FS indicated that contaminant concentrations were generally higher in the north and center of Site H than in the south, and the highest concentrations were generally from 10 to 25 ft bgs. (E&E 1998 pp. US06874-875).

It is noted that the compositing method used to collect subsurface soil samples in the E&E study (E&E May 1988 Sect. 3.6.1) may have lost VOCs to the air, and therefore the reported VOC concentrations in Table 3.3 may be biased low or may be falsely not-detected.

### **3.1.3 Site I**

Site I (eye), approximately 19 acres in area, is located north of Queeny Avenue, west of Falling Springs Rd and south of the Alton & Southern RR tracks. The Site is within Cerro Copper Products and comprises roughly the eastern third of the plant property. Dead Creek Segment CS-A forms the western border of Site I, inclusive. Thus CS-A is defined to be within Site I (E&E May 1988 pg. 4-21); however, it is discussed separately in this report (Section 3.2.1). The boundary of Site I is shown in Roux (2001 Fig. 3-3). Active disposal began at the site in about the mid-1940s (E&E May 1988 pp. 2-7, IA-1). Investigators differ on the date of last disposal of industrial wastes. Monsanto has reported that disposal ended in 1957, although that date referred jointly to Sites H and I (E&E May 1988 pg. IA-1). E&E (May 1988 pp. 2-45, 2-48) states (consistently) that all pits were filled by 1955-1962. ERI (2002 pp. 5, 13-15) notes multi-toned debris and liquid within disposal pits until 1967, and points out surficial disposal activities from 1962 through 1993.

Aerial photographic interpreters indicate the following for Site I. As discussed in section 3.1.2, an excavation is evident which straddles northern Site H and southern Site I in the earliest aerial photo in 1937, and this is consistent with the site initially operating as a sand and gravel borrow pit in that area. This excavation continues in 1940; liquid fills the excavation in 1943. In 1945 probable disposal activity is inferred for the eastern perimeter and NW corner of the pit; liquid fills the remainder of the excavation. In 1950 three excavated areas are visible including along the west border north of old Queeny Ave.<sup>17</sup>, a small area just south of old Queeny Ave., and the original excavation with northward expansion (IEPA 1981 Fig. 3c). The Sauget Town Hall under construction also is visible at this time. Debris, dark-toned material and excavated areas are visible onsite in 1953. According to IEPA, as of 1955 most of Site I except a portion of the north pit has been filled; elsewhere materials have settled creating a low-lying area west and northwest of the completed Town Hall; and troughs develop in the surfaces of the former pits (IEPA 1981 pg. 6). According to ERI (2002 pg. 13) disposal activity still is ongoing at the southern pits in 1960 and 1962. The north pit is filled by 1962 (E&E May 1988 pg. 2-45).

ERI (2002 pp. 13-15) describes more recent activities which also appear to involve release of wastes at Site I. In the north end of Site I between 1960-1967 a facility with

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<sup>17</sup> The original ("old") Queeny Avenue is north of, and parallels, the current ("new") Queeny Avenue. The old Queeny Avenue runs through the center of Cerro Copper bifurcating CS-A, through the bottom third of Site I, and just north of Sauget Town Hall. Both roads are shown on E&E (May 1988, Figure 3c).



## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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horizontal tanks and tank trucks and trailers and staining is visible, and a drainage channel leads from the facility to CS-A. In 1967 probable dredge material is added to the south part of Site I, and debris is visible. In 1968 the facility with tank trucks and trailers is gone, and multi-toned material is added in the area. Between 1971—1982 variously-toned material, some mounded, debris, liquid, staining, and trailers are visible. Impoundments with liquid are noted in central Site I from 1977-1979.

When viewed in 1985-86 Site I was being used for equipment and scrap storage and trailer truck parking; no waste material was evident at the surface (E&E May 1988 pg. 2-7). Cerro refused access for a 1987 or 1988 surface geophysical investigation of Site I (E&E May 1988, pp. 1A-2, 1A-6).

As noted in Section 3.1.2, the southern half of Site I operated contiguously with Site H and they are jointly referred to by Monsanto as the Sauget-Monsanto Landfill. Monsanto has reported to USEPA that subsurface disposal of organics, inorganics, and solvents in drums occurred at the Sauget-Monsanto Landfill from an unknown beginning date (E&E 1998 pg. US06980 and Roux 2001 pg. 2-3 estimate 1931) until 1957. The Landfill received chemical wastes from the Monsanto Queeny (St. Louis) and W. G. Krummrich plants (E&E 1998 pg. US06875). Chemical wastes disposed at the Sauget-Monsanto Landfill include drums of solvents, other organics and inorganics, including PCBs, 4-nitroaniline, chlorine, phosphorus pentasulfide, and hydrofluosilic acid. Site I also received contaminated sediments from dredging of Dead Creek Segment CS-A. In addition, municipal wastes reportedly were disposed at the Landfill; Monsanto has stated that Site I was "used as a landfill for wastes from throughout the metropolitan St. Louis area from the 1930s to the late 1950s" (Solutia 2000 pg. 3-4). (Roux 2001, pg. 2-3; E&E May 1988, pp. 2-42, 2-45, 1A-1; IEPA 1981, p. 6, Figs. 3c, 3d).

Fill material covers most of Site I and consists of 3 to 13 ft of sandy clay mixed with gravel, slag and less commonly asphalt. Crushed limestone gravel was placed at the surface in the southern half of the site to support truck traffic. The northern half of the site surface contains piles of construction debris, concrete and wood. Site borings have confirmed the two main disposal pits seen in historical aerial photos. The north pit is approximately 26 ft deep and the south pit is at least 23 ft deep. Beneath the fill the pits contain up to 13 ft of waste material including oily sand, clay, wood and cinders mixed with refuse, and a sludge-like material. The underlying Cahokia Alluvium fine sand and sandy silt deposits are stained below both pits. Waste within both pits extends well below the water table which averages 10 ft bgs. Figure 3.2 and Figure 3.4 show the interpreted waste thickness and depth and the water table at Site I. (E&E May 1988 Table 3-5, pp. 4-20 through 4-22, 7-11, 7-12).

The EE/CA—RI/FS characterization borings at Site I encountered uncontained solid "purple", "greenish-yellow", and "metallic shiny" substances. Maximum PID was 2000 ppm. (OBG Sep 2000 Vol. 1 part 2 pp. 50-57). Test trenches during the EE/CA—RI/FS exposed drums and drum fragments, some containing waste materials. Several drums were "fairly intact." Some drums contained "a solid yellowish material." Contents leaked out of some broken drums. Black soil, bricks, concrete, wood, plastic, and metal scraps also were encountered. (OBG Sep 2000 Vol. 8 part 2 pp. 97-109).

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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A chain-link fence and 24-hour surveillance camera control access to the entire Cerro facility including Site I. (E&E May 1988 pp. 2-7, 4-20 to 4-22; E&E 1998 pp. US06979-980).

Site I (excluding CS-A here) has been sampled for certain total and leachable (TLCP) waste constituents. Wastes and soils within Site I were sampled by E&E in 1987 and by Solutia in 1999 (E&E May 1988 Sects. 3.6.1, 4.2.4; E&E 1998; OBG August 30 2000). Table 3.4 lists detected maxima of the chemicals of interest. Particularly elevated substances include benzene, chlorobenzenes, chloroform, tetrachloroethene, anthracene, fluoranthene, naphthalene, 2,4-D, pentachlorophenol, lead, mercury, nickel, and selenium.<sup>18</sup> Sample I5-41 collected in 1987 contained 1.1% organic contaminants by weight (E&E May 1988 pg. 4-130).

Based on ground-water quality data for a downgradient well, Groundwater Services Inc. (May 2001) infers that dense non-aqueous phase liquids ("DNAPLs"; see Section 5.1.1) have been released to the Site I subsurface and lodge as "fingers" and "pools" in the saturated zone from approximately 15 to 110 ft bgs.

### **3.1.4 Site L**

Site L is located immediately east of Dead Creek CS-B and south of Metro Construction Company. The Site contains former unlined impoundments which received an estimated 164000 gallons<sup>19</sup> of truck-cleaning wash waters from two hazardous and special waste haulers—Waggoner & Company and Ruan Trucking. The boundary of Site L is shown in Roux (Fig. 3-4).

Harold Waggoner & Company specialized in hauling industrial wastes. The company began operations in 1964 and served companies in the St. Louis/Metro East area. Prior to August 6, 1971 Waggoner trucks were cleaned and the wash waters reportedly were discharged directly into Dead Creek CS-B. In April 1971 an IEPA inspector observed this practice; in July IEPA cited Waggoner for discharges to the creek, and in August Waggoner responded that all discharges had been diverted to a pit excavated on its property. This and subsequent adjacent pits have come to be known as Site L.

Waggoner & Company sold its operation to Ruan Trucking Company which reportedly continued the practice of discharging wash waters to the Site L pit until 1978. At that time the pit was leased to Tony Lechner of Metro Construction Company which subsequently purchased the property and covered the impoundment. (E&E May 1988, pp. 2-53, 2-54, L-1; IEPA 1981, pg. 12).

Aerial photographic interpreters indicate the following for Site L (E&E May 1988 pp. 2-48, L-1; ERI 2002 pg. 15). As of 1967 a building has been constructed, and tank trucks and tank trailers are visible. A square pit in the SW corner of Site L contains liquid. There is plume-shaped discoloration of liquid or material diagnostic of point-source discharge to CS-B (pipe, drainage ditch, etc.); this is termed an "outfall." In 1968 a second square

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<sup>18</sup> The third-most concentrated Site I subsurface organic in E&E (May 1988) was hexachlorobenzene (1300 mg/kg at station I5), which is not a selected chemical of interest.

<sup>19</sup> This IEPA rough estimate assumes that Ruan Trucking operated at the same volume as Waggoner (IEPA 1981, pg. 34; E&E May 1988, pp. L-1 to L-2).

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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pit appears in the SE corner, and a horizontal tank and staining exist north of the SW pit. (Thus these two pits have appeared years prior to the IEPA 1971 inspection!). As of 1971 the SE pit has been filled, and a new NE pit is present. The outfall persists. The 1973 photo clearly reveals the SW impoundment as well as discoloration in CS-B adjacent to Site L. As of 1974 there are two large liquid-containing pits: the SW pit and an eastern pit incorporating the NE and former SE pits. The SW impoundment is roughly 70 ft by 150 ft in planview with its closest edge about 125 ft east of Dead Creek<sup>20</sup> (E&E 1998 pg. US06878). In 1975-1977 these pits persist. There are fill areas on and east of the site and mounded material possibly mixed with debris adjacent to the pits. There is staining south of the main building. In 1978 more mounded material appears near the pits, and fill along the west border covers the former outfall area. The SW pit is filled by 1982 and the eastern pit is filled by 1985.

As of 1988 Site L was covered with black cinders, no waste material was visible on the surface, and the land was being used by Metro for equipment storage. Access to the site was not controlled. (E&E May 1988 pp. 2-7, L-1, Table 2-1).

Borings indicate that the Site L SW impoundment was unlined and relatively shallow. The fill within the former ponds consists of 4 to 8 ft of black cinders, clay, concrete and brick. A gray to brown clay and silt unit occurs at the surface in this vicinity; however, the deeper portions of the former excavation breached this layer. Thus in these deeper areas the fill lies directly on very fine sand and silt of the Cahokia Alluvium (Figure 3.6). The clay/silt and sand materials within the former impoundment (borings L2, L3) are extensively stained from base-of-fill (appx. 5 ft bgs) to at least bottom-of-boring at 20 ft bgs. In one boring (L4) offset from a former pond, staining is first encountered 10 ft bgs at the approximate water table. This suggests that contamination migrated vertically to the water table beneath the pond and then laterally in the direction of ground-water flow. Figure 3.2, Figure 3.5, and Figure 3.6 show the interpreted waste thickness and depth and the water table at Site L. (E&E May 1988 Table 3-5, Fig. 3-7, pp. 4-22, 4-23; G&M 1992 pg. 1-5, Fig. 3-1; E&E 1998 pg. US06878).

Two rows of equipment in the middle of Site L complicated the surface geophysical surveys conducted at Site L in 1985. However, one significant magnetic anomaly was delineated in the SW corner of the site and a second was found (but with interference) between the two rows of equipment. A significant shallow EM anomaly approximately 150 by 100 ft planview was evident in the southeast corner of the site (also detected at depth with smaller cross-section). According to E&E in 1988, these geophysical data and (unspecified aspects of) the historical aerial photos indicated the likely presence of waste residues extending to farmland south of Site L. (E&E May 1988, pp. 4-7, 4-11, L-4, L-5, Fig. L-1).

The EE/CA—RI/FS characterization borings encountered a variety of fill materials but no specific uncontained waste substances. The maximum PID reading was 728 ppm. (OBG Sep 2000 Vol. 1 part 2 pp. 58-62). Trenching in Site L during the EE/CA—RI/FS revealed 18 drums (more deemed likely by the contractor), drum fragments, and uncontained solid chemical waste. Several of the drums bore Monsanto labels. A black

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<sup>20</sup> A later inspection by G&M found impoundment dimensions of 165 ft by 35 ft (E&E 1998 pg. US06878).

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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tar-like substance was noted to be leaking from several drums. Trenching also encountered bricks, rags, small pieces of concrete, and other refuse. (OBG Sep 2000 Vol. 8 part 2 pp. 51-57).

Site L has been tested for certain total and leachable (TCLP) waste constituents. Wastes and soils within Site L were sampled by IEPA in 1981, by E&E in 1986, by Geraghty & Miller in 1991, and by Solutia in 1999 (E&E May 1988 Sects. 3.6.1, 4.2.4; E&E 1998; OBG August 30 2000).<sup>21</sup> Maxima of chemicals of interest for each sampling event are listed in Table 3.5. Organics at or above 100 mg/kg include toluene, 4-chloroaniline, 1,4-dichlorobenzene, 3- or 4-methylphenol, and PCBs. Nickel is over 90 times its background concentration (Table 3.10).

### **3.1.5 Site M**

Site M is located on the east side of Dead Creek CS-B, south of Site L, at the west end of Walnut Street. The Site is an inundated former sand borrow pit owned and excavated by the H. H. Hall Construction Company. Access to the pit was unrestricted until 1980 when a snow fence was erected (E&E May 1988, pg. M-1).

Aerial photographic interpreters indicate the following for Site M (E&E May 1988 pp. 2-45, 2-48; ERI 2002 pp. 16-17). In 1943 a liquid-filled excavation is first evident, and there is a hydraulic connection to CS-B. In 1953 fill material is excavated from the SE corner of the site, and fill is added to cover the connection to CS-B. In 1955 the excavation remains but contains less liquid than before. From 1960-1982 the connection to CS-B is once again visible and remains so until 1998. The area is flooded in 1993.

The Site M pit is approximately 220 ft x 320 ft x 15 ft with a water depth of up to 14 ft (E&E 1998 pg. US07041-042; Roux 2001 pg. 2-4).<sup>22</sup> It is hydraulically connected to CS-B via an approximately 8-ft wide drainage-way extending west from the southwest corner of the pit.<sup>23</sup> A residential area is located immediately east of the pit on Walnut St. IEPA and Cahokia Health Department have received numerous complaints about Site M and the creek from residents in this area, including concerning seepage of odoriferous water into basements and problems associated with well water used for irrigation. IEPA inspections observed discoloration in the Site M pit similar to that observed in Dead Creek. No information is available in IEPA files concerning waste disposal activities at Site M. (E&E May 1988 pg. M-1, Fig. M-1).

As of 1988 the Site M pit remained filled with water of nonspecific origin (rainfall, runoff, and/or ground-water discharge). The east bank of the pit was strewn with trash and debris; no other evidence of waste disposal was apparent. The 1991 field study by G&M

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<sup>21</sup> E&E (May 1988 pp. L-3, L-4) uses sample X125 of the IEPA (1981) study to characterize Site L. However, according to Figure L-1 of E&E (May 1988), as well as to IEPA (1981, Fig. 8), X125 is not located sufficiently close to Site L to serve that purpose.

<sup>22</sup> Estimated depth of the Site M pit is a much larger—and apparently erroneous—40 ft in E&E (May 1988 pg. 2-14).

<sup>23</sup> IEPA (1981, pg. 34), observing that the water level in the Site M pond exceeded that in nearby ground-water wells by 1.5 to 2 ft, ruled out ground-water exchange with the pond and attributed the perched water condition to silt accumulation on the pond bottom. However, the author apparently was unaware of the surface-water link between Site M and CS-B. Flow from the creek to the pond likely maintained the observed head differential.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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encountered 0.5 to 5.5 ft of sediment underlying the pond; average sediment thickness is about 1.6 ft. The highest thicknesses occur in the southwest corner of Site M, possibly due to sediment deposition from water flowing in from Dead Creek (G&M 1992 pp. 3-3, 3-4). Figure 3.7 is a cross-section through Site M that illustrates the sediment layer. As mentioned in Section 3.2.1, Site M is enclosed by the chain-link fence which also encircles CS-B. (E&E May 1988, pg. 2-14).

Site M has been tested for certain total and leachable (TCLP) waste constituents. Water and sediment within Site M were sampled by IEPA in 1980 and 1994, by E&E in 1986, by G&M in 1992, and by Solutia in 1999 (E&E May 1988 Sects. 3.6.1, 4.2.4; G&M 1992; E&E 1998; OBG August 30 2000).

The sediments in Site M have been contaminated with numerous chemicals of interest. Table 3.6 lists detected maxima. VOCs benzene, chlorobenzene, ethylbenzene, and trichloroethene were present in one or more samples.<sup>24</sup> Numerous SVOCs were detected in Site M sediment; 1,4-dichlorobenzene also was detected in a TCLP sample. PCBs were consistently very elevated (up to 1100 mg/kg). G&M estimates that 3,600 yd<sup>3</sup> of sediment within Site M were impacted by PCBs (G&M 1992 Sect. 4.3). Metals of interest exceeding ten times background<sup>25</sup> (Table 3.10) include lead, nickel, and zinc.

### **3.1.6 Site N**

Site N is located in the SW corner of an inactive construction yard along the east side of Dead Creek CS-C south of Judith Lane and north of Cahokia St. The boundary of Site N is shown in Roux (Fig. 3-5). The construction yard is owned by H. H. Hall Construction Company. The site is a four-acre former borrow pit which was excavated to provide road construction materials. According to the owners, Hall Construction partially refilled the pit with only construction and demolition wastes such as concrete rubble (E&E May 1988, pg. N-1).

This historical information on activities within Site N does not suggest that hazardous waste was disposed there, although in one boring staining was noted on silt and sand sampled from 6-10 ft bgs (E&E 1998 pg. US07140). Therefore it was a surprise when EE/CA—RI/FS trenching encountered rusted drums and drum fragments, some containing chemical wastes. Whitish and pasty white substances were noted in several drums as well as uncontained within the trench. PID readings inside drums reached 870 ppm. Bricks, scrap tires, concrete, and other refuse also were found during trenching. (OBG Sep 2000 Vol. 8 part 2 pp. 36-51). The EE/CA—RI/FS Site N characterization borings encountered an unidentified green material. Maximum PID reading of recovered waste material was 65.7 ppm. (OBG Sep 2000 Vol. 1 part 2 pp. 63-68).

Aerial photographic interpretation indicates the following for Site N (ERI 2002 pp. 17-18). Excavation is first evident in the 1945 photo. In 1947 the excavation is larger and filled

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<sup>24</sup> The use of a medium-concentration methodology to analyze sediment VOCs samples in the E&E (May 1988) study likely obscured VOCs in sediments in all stream segments and Site M. The single sediment sample in that study which did use low-concentration methodology detected six VOCs (E&E May 1988 pg. 4-94).

<sup>25</sup> An order of magnitude excess over background (itself a maximum herein) is a conservative criterion for the presence of contamination and is selected to make false positives unlikely.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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with liquid. In 1948 only the deeper portion of the excavation contains liquid. In the 1950 photo ground-water is present in the excavation. (The approximately 25 ft depth of the ground-water table of that period [E&E May 1988 pg. 2-45] implies an excavation depth exceeding that value).<sup>26</sup> In the 1955 photo the water table has dropped below the pit bottom (probably due to drought conditions prevailing in the East St. Louis area from 1952-1956 [Schicht 1965, pg. 39]). During 1950 through 1960 a drainage channel is visible on the south side of Area N leading to CS-C. In 1953 light-toned material or liquid exists at the mouth of the ditch. The ditch likely was dredged in 1960, and has been filled and graded by 1962. In 1960 a new excavated and/or ground-scarred area exists in the SE corner of the Site. In 1968 evidence first appears of disposal, including multi-toned material and probable debris in the SE corner. During 1971-1982 disposal of debris and a variety of materials is evident. A new excavation appears north of Site N in 1982. The original excavated area is finally filled by 1988; debris remain on its surface and extend to the northern excavation.

As of 1988 the pit remains below the surrounding grade. The property is being used only for equipment storage. A chain-link fence with padlocked gate controls access; it is not known when access to Site N first was restricted. (E&E May 1988, pp. 2-45, 2-48, N-1, N-3, Fig. N-1).

Site N has been tested for certain total and leachable (TCLP) waste constituents. Soils within Site N were sampled by E&E in 1986 and by Solutia in 1999 (E&E May 1988 Sects. 3.6.1, 4.2.4; E&E 1998; OBG August 30 2000). Concentration maxima for chemicals of interest are shown in Table 3.7. Detected VOCs include benzene, 4-methyl-2-pentanone, and trichloroethene. Several PAHs were found in one of the soil borings. PCBs were not detected. Mercury (9 mg/kg) exceeded 10x background (Table 3.10); no other metals were present above background.

### **3.2 Dead Creek**

Dead Creek was used as a receptacle for liquid wastes for many decades. These wastes arrived in point-discharged effluent from pipelines along the creek and in surface-water runoff. It is my understanding that waste disposal to creek segments CS-A and CS-B is described in the expert report by Mr. Klingenstein. Except for downstream migration of contaminants within the creek, and perhaps discharge from Site N, in my report no waste disposal has been identified to creek segments CS-C through CS-F.

#### **3.2.1 Segment A (CS-A)**

The former Creek Segment A ("CS-A") of Dead Creek stretches 1700 ft from the Alton & Southern RR at the north end to Queeny Avenue in the south. Thus CS-A was entirely within the current Cerro property. CS-A lies within Site I (E&E May 1988 pp. 4-21) but is discussed separately herein. This subsection also briefly considers the portion of Dead Creek which at one time existed upstream of CS-A.

Before the 1932-33 construction of the Village sewer system, industrial process wastewater from many East St. Louis and Sauget industries flowed into Dead Creek

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<sup>26</sup> Roux (2001 pg. 2-5) states that Site N fill may be as much as 30 ft thick.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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(Roux 2001 pg. 2-28). Local industries along the creek channel discharged their waste waters directly into Dead Creek (Homer & Shifrin 1994 pp. 18, 22).

By the early 1930s a 1000-ft stretch of Dead Creek beginning at Monsanto Avenue was filled in and used for industrial building sites by Monsanto Chemical (Homer & Shifrin 1994 pg. 21). Runoff from the Monsanto property continued to pass through a 36-inch diameter culvert under the RR and enter the new head of Dead Creek at the north end of CS-A. (Roux 2001 pp. 2-28, 2-29).

CS-A served as a surge pond for the Village industrial/municipal sewer system from ca. 1939 through 1990.<sup>27</sup> Thus contaminants within the sewage were released to CS-A during that period.

Dead Creek CS-A was dredged and the spoils were deposited along the creek banks and within current Site I. Thus contaminants within the sewage were released to the land surrounding the creek.

The timing of the CS-A dredging is of interest. Dredging before ca. 1939 implies that any industries whose private sewers or contaminated surface runoff emptied into Dead Creek within or upstream of CS-A likely contributed to contamination within Site I. Dredging after ca. 1939 implies that any industries whose Village-sewered waste overflowed to the Dead Creek surge pond likely contributed to contamination within Site I. According to Roux (2001 pg. 2-29) and Solutia (2002 pg. 2-7) CS-A was dredged at least in 1935, and "such dredging may have occurred more than one time." Aerial photographic interpretation indicates dredging of CS-A with probable dredge materials deposited on the adjacent banks in 1947 (ERI 2002 pg. 19). Several documents refer to multiple dredging events, but dates are not provided (OBG 1999 Vol. 2A pg. 12; Solutia 1999 pp. 3-4; OBG 2000 Sect. 3.20; Roux 2000 pg. 2-5; Tetra Tech 2000 pg. 8). Even so, from context it appears that the dredging was prompted by sediment accumulation within the surge pond, thus placing it in the post-ca. 1939 period (Solutia 1999 pp. 3-4; Roux 2000 pg. 2-5).

Discoloration of CS-A is visible in aerial photographs from 1943 onward (E&E May 1988 pp. 2-45, 2-48, 2-51; ERI 2002 pp. 18-20). In May 1975 an IEPA field inspector observed discoloration of the water and creek bank along CS-A (E&E May 1988, pg. 2-55). As of 1988 the water in CS-A was highly discolored and oily, staining the creek banks. There was a heavy oily scum on the water surface near the sewer interceptor pipe at the north end of the pond. Cerro stated that no process wastewater, cooling water or other waste was then being discharged to the ponds. (E&E May 1988, pp. 2-7, 4-21). However, CS-A continued to serve as a sewer system surge pond.

In 1989 Cerro retained The Avendt Group to conduct a Site Investigation/Remedial Alternatives Evaluation for CS-A. The study found that fill deposits ranged from 1 to 15 ft thick, and consisted of tan to black, stained silt to silty sand with intermixed concrete, brick, road aggregate, rags, slag and vitreous pellets. Analytical results (discussed below) prompted Cerro to excavate and remove 27,500 tons of contaminated fill and

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<sup>27</sup> Herein I use "ca. 1939" to indicate the date of the hookup of the 36" Alton & Southern RR culvert to the Village Sewer. The actual date is uncertain but reportedly between 1939-1943.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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fluidized creek bottom sediments during 1990. Excavated sediment varied from 0.5 to 11 ft thick and is described as brown to yellowish brown and black silt with organic matter. (G&M 1992 pp. 1-5, 1-6, Sect 3.4; E&E 1998 pg. US06983; Roux 2001 Sect. 2.3.1). A high density polyethylene ("HDPE") liner was placed in the excavated channel, and CS-A was backfilled and covered with crushed gravel to grade (Roux 2001 pg. 2-5).

Creek segment CS-A has been tested for certain waste constituents. Sediments within CS-A were sampled by IEPA in 1980 and 1981, by E&E in 1986 and by Advent Group in 1989 (IEPA 1981; E&E May 1988 Sects. 3.6.1, 4.2.4; E&E 1998). The Advent Group study was particularly intensive, collecting sediment samples from 34 borings along 10 transects (G&M 1992, pp. 1-5, 1-6). Table 3.8 lists maxima for the chemicals of interest.

Sediment VOCs within CS-A include benzene, chlorobenzene, 1,2-dichloroethene, ethylbenzene, tetrachloroethene, toluene, trichloroethene, and xylenes. SVOCs include 4-chloroaniline, chlorobenzenes, naphthalenes, pentachlorophenol, and numerous PAHs. PCBs are quite elevated (maximum 1600 mg/kg). Metals above 10x background (Table 3.10) include chromium, lead, mercury, nickel, selenium, and zinc.<sup>28</sup>

CS-A surface water was sampled by IEPA in 1981 (for metals and PCBs) and by E&E in 1986. The CS-A ponds were no longer present at the time of the EE/CA—RI/FS. Maxima for chemicals of interest are shown in Table 3.8. Detected VOCs in 1986 include benzene, chlorobenzene, chloroform, 4-methyl-2-pentanone, and trichloroethene; SVOCs include 4-chloroaniline and phenanthrene. Elevated metals in both 1981 and 1986 include lead, mercury, nickel and zinc. PCBs were detected in 1981 (28 ug/l) but not in 1986. As is standard practice, the surface water samples were not filtered.

### **3.2.2 Segment B (CS-B)**

Segment B of Dead Creek ("CS-B") stretches from Queeny Avenue to Judith Lane in Sauget and Cahokia. Sites G, L, and M lie adjacent to CS-B. The CS-B creek banks are heavily vegetated. Flow is intermittent and storm-dependent (E&E May 1988 pp. 4-23, B-1).

Culverts at both ends of CS-B were blocked: at Judith Lane in ca. 1939 creating the Dead Creek surge pond which initially included both CS-A and CS-B, and at Queeny Avenue in 1968 severing CS-B from the surge pond. However, the adequacy of these barriers has been questioned by IEPA. In any case contaminated surface water arrived from upstream before and during the period that CS-B was within Dead Creek Surge Pond. (E&E May 1988 pp. 4-24, B-1, B-2; E&E 1998 pg. US 07046).

Industrial or commercial wastes also were discharged directly into CS-B. Waggoner Company, an industrial waste hauler, discharged truck wash waters into the creek until IEPA intervened in mid-1971 (E&E May 1988 pp. 2-53, 2-54). After that time wastes were discharged to unlined pits (Site L) adjacent to Dead Creek. The Midwest Rubber Company reportedly discharged process wastes including oils and cooling water into CS-B via a sewer overflow pipeline. Consistent with such disposal, a rubbery waste material is found on the creek bed of the upper half of CS-B. A second "old effluent pipe"

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<sup>28</sup> Sediments sampled from CS-A in March 1982 reportedly leached lead above EP-toxicity limits (E&E May 1988, pg. 2-60). I have not located these sampling or analytical results.



## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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also is located in the upper 300 ft of CS-B, and staining is evident around both of the pipes (E&E May 1988, pg. 7-24). An outfall was observed by aerial photography between 1968-1982 north of the Site L pits (ERI 2002 pp.21-22); perhaps this pipe was the source of the outfall. Storm runoff from adjacent properties, including Metro Construction, also enters CS-B. (E&E May 1988 pp. 4-23, 4-24, 7-12, B-22; E&E 1998 pg. US07046).

Aerial photographs reveal discolored stream water in CS-B from 1940 onward (E&E May 1988, pp. 2-45, 2-48, 2-51; ERI 2002 pp. 21-22). In 1975 IEPA inspectors observed discoloration in the creek and along the banks similar to that later observed at CS-A (E&E May 1988 pp. 2-55, B-2). Fires and smoldering in CS-B were reported in July 1979 and May 1980 (E&E May 1988 pg. 2-56). In August 1980 a neighborhood dog rolled in the CS-B channel and died of apparent chemical burns (IEPA News 1980; E&E May 1988 pg. B-1).

In September 1980 IEPA placed a seal order on CS-B and Site M, and the Illinois Department of Transportation installed a 7000-foot snow fence with warning signs around the area (E&E May 1988, pg. 2-57). October 1980 air samples in CS-B revealed the presence of volatile organics and hydrocarbons (not quantified) (E&E May 1988, pg. 2-58). In October 1982 USEPA completed construction of a chain-link and barbed wire fence to replace the snow fence (E&E May 1988, pp. 2-61, B-2). As of 1988 debris was scattered throughout the northern half of CS-B. (E&E May 1988, pp. 2-8, B-1).

Creek segment CS-B has been tested for certain waste constituents. Sediments and/or water within CS-B were sampled by IEPA in 1975, 1980, 1993 and 1994, by E&E in 1986, by G&M in 1991 and by Solutia in 1999 (IEPA 1981; E&E May 1988 Sects. 3.6.1, 4.2.2, Table 4-9, App. D; E&E 1998; OBG August 30 2000). Table 3.9 lists detected maxima for the chemicals of interest.

The sediments in CS-B have been contaminated with a variety of chemicals of interest. Table 3.9 lists detected maxima from the early 1980s IEPA samples (grouped) and from each of the three more recent sampling programs. Of VOCs, the three more recent programs all detected chlorobenzene and toluene; and G&M and E&E also both detected ethylbenzene and xylenes. Numerous SVOCs were detected in CS-B sediment, including the following in every sampling event (if analyzed): 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, pentachlorophenol, naphthalene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, and PCBs (up to 230 mg/kg). Metals exceeding ten times background (Table 3.10) include all of the metals of interest except vanadium. If one restricts attention to sediment analyses from the EE/CA—RI/FS, then the metals exceeding 10x background are mercury, nickel, selenium, and zinc.

On May 31, 2000 USEPA issued a UAO for a Time-Critical Removal of CS-B and other creek sediments and soils and floodplain soils to eliminate potential risks associated with flooding and to eliminate adverse ecological impact. As of June 2002 sediments have been removed and liner material placed in CS-B adjacent to Site G, and additional work is ongoing. (USEPA May 2000; Roux 2001 Sect. 2.3.5; Solutia 2002 Sects. 1.4.4, 2.2.5,

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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2.3.4). Extensive confirmatory sediment sampling has been conducted during this task; however, I received the results too late for their incorporation into this report.

### **3.2.3 Segments C (CS-C) through F (CS-F)**

These downstream creek segments have been impacted by surface-water borne migration of contaminants from CS-A and CS-B. However, in this report I do not evaluate releases of contamination to ground water from Dead Creek segments CS-C through CS-F.

### **3.3 Overflowing and Leaking Village Sewers**

Village sewers are discussed in this report because of their role in the release of hazardous wastes to the ground water at the site. The Sauget sewer system functioned in two ways to release contamination to Area 1 ground waters:

- (1) for several decades beginning in 1932-33 waste liquids were discharged from overflowing sewer lines into CS-A and CS-B, and infiltration conveyed contamination downward to the ground water; and
- (2) leaking sewer pipes discharged waste water to surrounding soil, and infiltration carried contaminants to underlying ground water.

It is my understanding that Mr. Klingenstein's expert report describes the history, locations, and mechanisms of release of Village sewage to the Area 1 environment, including both the intended storage of overflow in the Dead Creek surge pond and the unintended exfiltration of sewage from leaking pipes.

A portion of the sewage which moved from the sewers to the surge pond subsequently infiltrated from the pond to the ground water. In addition any leakage past the blocked downstream culvert at Judith Lane (say, during flooding) carried contaminants into lower Dead Creek (CS-C and beyond) where infiltration also occurred.

According to Monsanto consultants Geraghty and Miller, Inc. sewer leakage was a problem. "[T]he old [pre-1989 Village] sewer system is suspected of being a major source of contaminant loading to the ground water" (G&M 1986, Vol. 2, pg. 10). As of 1986 planned or recently completed replacement and repair of Village and WGK sewers was expected to "significantly reduce contaminant loading to the ground-water system" (G&M 1986, Vol. 2, pp. 9-10).

It is my understanding that Mr. Klingenstein's report provides opinions on historical Area 1 sewer leakage frequency, location, and water quality. I understand that Mr. Klingenstein will point out the sewer lines within Area 1. It is my understanding that Mr. Klingenstein has not yet identified specific leaky sewer locations or rates of leakage given available data, but that he does opine that unquantified releases occurred at unspecified locations within Area 1 along the Village sewers.

It is my opinion that liquid wastes which exfiltrated from Area 1 sewers then infiltrated through the surrounding and underlying Cahokia Alluvium to the ground-water table. Such releases to the ground water occurred at points of leakage whenever the local sewer head exceeded the ground-water table.

## **Sauget Area 1 -- Expert Report on Ground Water Contamination**

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Absent information on specific points of leakage, I cannot point to corresponding evidence of specific ground-water quality impacts from leakage. I note that the Mississippi Ave. sewer is on the west (outside) of Rt. 3 which forms the boundary of Area 1. Therefore any recent leakage from this line affects Area 1 ground water only in the sense that water quality of the ground water leaving Area 1 is further degraded as it enters Area 2. On the other hand when ground water in this vicinity flowed toward Monsanto and other major pumping centers to the NE (i.e., prior to appx. 1970), exfiltration from this sewer line was carried northeastward into Area 1.

Sewered wastes attributable to each industry and the historical water quality of sewer flow which moved through Area 1 sewers and into the surge pond are matters addressed by other experts for the US in this litigation. Their results are not yet available to me; however, I expect to incorporate them into my opinions concerning the specific hazardous substances released to the ground water from the sewers.

## **4. ENVIRONMENTAL SETTING**

Sauget Area 1 Site is located in southwestern Illinois, in the Till Plains Section of the Central Lowland physiographic province, in a portion of the Mississippi River floodplain known as American Bottoms. It lies within the northern temperate zone which is characterized by warm summers and moderately cold winters. Average precipitation is about 38 inches/year, with monthly averages greatest in March through June and gradually declining until December. Much of the summer rainfall occurs as thunderstorms which periodically cause isolated flooding; one to two-inch rainfalls are common. Average calculated evapotranspiration is 33 inches/yr; hence the average potential surplus available for surface water runoff and ground water recharge is about 5 inches/yr. The land surface at the site is very flat excepting portions of steep bank along Dead Creek. Land elevation in the vicinity is about 400 to 445 ft NGVD. Elevations at Sauget Area 1 sites range from 400 to 410 ft above mean sea level ("MSL"). (Schicht 1965, pg. 3; IEPA 1981, pp. 2, 5; E&E May 1988, Sect. 2.2.3; G&M 1992 Sect. 3.2).

### **4.1 Surface-water Hydrology**

Dead Creek drains a portion of the American Bottoms including most of Area 1. Prior to industrial development Dead Creek was a free-flowing north-to-south draining ditch and stream which originated in or beyond the City of East St. Louis (Homer & Shifrin 1994 pg. 21) and flowed south, including through Area 1, to the Prairie du Pont Floodway which discharges to the Cahokia Chute of the Mississippi River. Total distance along Dead Creek from Judith Lane to the Mississippi River (i.e., excluding segments CS-A and CS-B) is approximately 4.2 stream miles. There is very little topographic relief within the drainage basin of Dead Creek. A system of levees fronting the river protects the area from flooding by the Mississippi. (E&E May 1988, Sect. 2.2.1.1). However, flooding does occur in parts of the American Bottoms due to inadequate drainage facilities (Schicht 1965, pg. 3).

Site investigators have partitioned Dead Creek into six "Creek Segments" denoted CS-A through CS-F.

CS-A. As discussed in Section 3.2.1, Creek Segment A ("CS-A") no longer exists but formerly stretched 1700 ft from the Alton & Southern RR in the north to new Queeny Avenue in the south. In ca. 1939 the Dead Creek culvert at Judith Lane was plugged and the Village Sewer System was linked to the upstream end of CS-A via a 36" pipe running beneath the Alton & Southern RR. These measures converted CS-A and CS-B into a surge pond (a.k.a. surcharge basin or overflow pond) within the sewer system. In 1968 the Dead Creek culvert under new Queeny Avenue was sealed with concrete to restrict flow from CS-A to the remainder of Dead Creek (E&E May 1988 pg. 1A-2; Roux 2001 pg. 2-5). This also severed CS-B from the surge pond. CS-A continued to function as a surge pond.<sup>29</sup> IEPA personnel observed flow from the downstream side of the Queeny Avenue culvert plug, apparently in the 1980s. The plug also contained a storm sewer which could account for the observed flow, but the possibility remains of leakage from CS-A to CS-B after 1968. In 1990 Dead Creek Segment A was excavated and backfilled

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<sup>29</sup> Old Queeny Avenue crossed the pond, giving it the appearance of two ponds. I have no information on how the two ponds were hydraulically connected.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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to grade by Cerro during an IEPA-approved remedy. (E&E May 1988, Sect. 2.2.1.2, pg. IA-2; IEPA 1981, pg. 19; Roux 2001 pg. 2-5).

**CS-B.** CS-B extends approximately 1800 ft from new Queeny Avenue to Judith Lane. The gradient of the streambed is slight, dropping only 1.35 ft over its 1800 ft length. In ca. 1939 the culvert at the downstream end (Judith Lane) was blocked and, along with CS-A, CS-B was incorporated into the Village sewer system surge pond. The 1968 sealing of the Queeny Avenue culvert severed CS-B from the surge pond; however, to protect the downstream creek Judith Lane culvert was not reopened. Water does not usually emerge from the Judith Lane culvert, but does do so after the creek reaches a sufficiently high, undetermined elevation. Flow emanating from the Judith Lane culvert has been observed on several occasions. Water level in CS-B varies substantially as a function of precipitation, and during extended periods of low precipitation the creek becomes a dry ditch. (E&E May 1988, Sect. 2.2.1.2, pp. 2-8, 4-23, B-1, C-1; IEPA 1981, pg. 19).

**CS-C through CS-F.** Dead Creek downstream segments C through F lie south of Judith Lane in the Village of Cahokia. Segments CS-C (1300 ft from Judith Lane to Cahokia St.) and CS-D (1100 ft from Cahokia St. to Jerome La.) flow unrestricted through principally residential areas. Segment CS-E (4300 ft from Jerome La. to the intersection of IL Route 3 [Mississippi Ave.] and Route 157 [Camp Jackson Rd.]) flows through a primarily commercial area and is unrestricted except for channelization through corrugated pipe at the downstream end of the segment. Segments C, D, and E flow intermittently. (E&E May 1988 pp. 2-18, C-1; E&E 1998 pg. US07143; Roux 2001 pg. 2-6).

Segment CS-F (6500 ft from Route 157 to Prairie du Pont Creek) is the longest and widest of the defined Dead Creek segments. Near the end of its course CS-F merges with the downstream third of Borrow Pit Lake, a long (6000 ft), narrow (500 ft) wetland area. Borrow Pit Lake was formed by excavation for a local levee system some time after 1954. During periods of no or low precipitation there is little or no flow in Borrow Pit Lake upstream of the CS-F junction. CS-F discharges into Old Prairie du Pont Creek. (Roux 2001 pp. 2-6, 2-7).

Flooding occurs in Area 1. Contributing factors include low topographic relief, lack of a storm-water drainage system in developed areas, and under-sized road culverts along Dead Creek. During significant precipitation events surface-water runoff is unable to drain sufficiently to prevent ponding and backup. "The creek overflows at the same time that the banks and adjacent areas begin to flood due to lack of relief, resulting in flooding of the entire area" (Roux 2001 pg. 2-9). Roux (2001 Sect. 3.4) describes the flood-prone area as lying between Queeny Avenue, Falling Springs Rd., Route 157 (Camp Jackson Rd.) and Route 3 (Mississippi Ave). In approximately 2000 Solutia replaced Dead Creek culverts at Cargill Road and at the Terminal Railroad embankment, but hydraulic modeling indicated that the potential for flooding would not be reduced (Roux 2001 Sect. 2.3.4).

Surface water drainage within Sauget Area 1 is generally toward Dead Creek. However, significant site-specific drainage patterns exist and have varied over time:

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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In 1988 Site G generally drained toward CS-B; however a large depression in south-central Site G collected runoff in its vicinity. A 1995 emergency action capped Site G; surface flow subsequently has flowed radially from the site.

As observed in 1988 and in the EE/CA—RI/FS, Site H generally drained toward CS-B; however, several small depressions trapped rainwater which subsequently infiltrated the ash cinder cover.

In 1988 Site I generally drained toward the ponds of CS-A; however, a large depression in northern Site I entrained rainwater. CS-A also received surface and roof drainage from the entire Cerro plant via storm sewers and effluent pipes; in 1985 or 1986 five drain pipes projected from the west bank of the ponds. As described in the EE/CA—RI/FS, runoff from the southern end of Site I enters a catch basin north of Queeny Avenue which drains into CS-B. In addition some precipitation infiltrates due to the flat grade and permeable stone parking areas.

As of both 1988 and the EE/CA—RI/FS field work, Site L generally drained toward CS-B; however, the highly permeable cinder cover induced substantial infiltration.

As of both 1988 and the EE/CA—RI/FS field work, Site M received surface runoff from a residential neighborhood to the southeast, and drained via a drainage way to CS-B.

As of both 1988 and the EE/CA—RI/FS field work Site N, which is topographically depressed, collected surface runoff from the surrounding area. The lowest point in Site N was about ten feet below the bank of CS-B.

(Roux 2001 pp. 2-8, 2-9; E&E May 1988, Sect. 2.2.1.2, pg. 1A-2; IEPA 1981, pg. 19)

### **4.2 Geology**

Over geologic history the ancestral Mississippi River has carved a wide, deep valley two to eight miles across and up to 170 ft deep into the sedimentary bedrock underlying the river. In the area of interest unconsolidated alluvium and glacial outwash, jointly referred to as "valley fill", now occupy this bedrock valley including beneath the current Mississippi River, the American Bottoms drainage basin, and particularly the site. The valley fill thins away from the river. In the vicinity the valley fill ranges from approximately 140 ft thick near the river to 70 ft thick (E&E May 1988 pg. 2-29) or 100 ft thick (Roux 2001 pg. 2-12) on the east side of Area 1.

Two unconsolidated geologic deposits are present within the valley fill at the site: the surficial, recent, Cahokia Alluvium and the underlying, glacial, Mackinaw Member of the Henry Formation ("Fm.") (Figure 4.1).

The Cahokia Alluvium consists predominantly of thin discontinuous beds of silt, clay and fine sand deposits, typically with coarser material intertonguing with finer-grained deposits. In the Sauget area the Cahokia Alluvium was created by flood events of the Mississippi River and by redeposition of eroded upland loess (wind, or "eolian", deposits) and till by tributary streams. (IEPA 1981 pg. 15, Fig. 5; E&E May 1988 pp. 4-11, 4-12). With depth the percentage of silt gradually decreases while sand percentage and grain size gradually increases. This results in a nearly clean fine- and medium-grained sand at

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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the base of the Cahokia which grades nearly imperceptibly into the sand and gravel of the underlying Henry Fm. (E&E May 1988 pg. 4-12).

The Mackinaw Member of the Henry Fm. is composed of Wisconsinian sand and gravel glacial outwash in the form of valley train deposits. Sands at the Site in the upper portion of the Henry Fm. are fine- to coarse-grained and coarsen with depth. Little to no silt-size particles are present in the Henry Fm. The several former sand pits at the Site were excavated to obtain these sands for commercial purposes.<sup>30</sup> Thickness of the Henry Fm. is variable (70 to 100 ft) and interbedding is complex due to the formative fluvial processes. At many locations bands of coarse gravel, cobbles and occasional boulders are found at depths greater than 75 ft bgs. In some areas clays with limestone fragments (evidently weathered bedrock residuum) were encountered 10 to 15 feet above the base of the Henry Fm. (Solutia 2002 pg. 1-7). The unit lies directly on Mississippian age limestone and sandstone bedrock.

In the Sauget area at most locations it is not possible to differentiate the lower Cahokia Alluvium from the upper Henry Fm. on the basis of mineralogical and textural characteristics or lithologic breaks. This is due principally to reworking of the lower Cahokia and upper Henry by river scour-and-fill during recent geologic time. (E&E May 1988 pg. 4-12; Roux 2001 pg. 2-12). This ambiguity may explain the variation in estimates of Cahokia Alluvium thickness at the Site, which according to IEPA (1981, pg. 15, Fig. 5) based on 12 test holes is 6 to 17 feet thinning eastward, and according to Roux (2001, pg. 2-12) is about 30 ft.<sup>31</sup>

The uppermost bedrock units beneath the alluvial deposits at the Site include the St. Genevieve and St. Louis limestones of the Mississippian System. More generally the Mississippian System contains numerous limestone, shale, siltstone, dolomite and sandstone layers.

At one time Dead Creek had sufficient flow and energy to erode through the silt and clay deposits of the upper Cahokia Alluvium into the fine sands and silty sands typically found at the base of the Cahokia or top of the Henry Fm. As creek velocity decreased the creek bed infilled with clayey silt. In 1980 five hand auger borings through Dead Creek CS-B to the underlying sands revealed loosely compacted silty clay to clayey silt about 8-10 ft thick. (IEPA 1981 pg. 15, Fig. 6b; E&E May 1988 pg. 4-23). Another study found that the base of the CS-B channel lies approximately at elevation 399 ft NGVD. The creek is underlain by about two feet of black spongy sediments. A variable thickness layer of clay and silt occurs beneath the spongy sediments. The thickness of the clay and silt is about five feet next to Site L and about two feet next to Site M (G&M 1992 pg. 3-3, Figs. 3-1, 3-2).

(Roux 2001 Sect. 2.1.5; E&E May 1988 Sects. 2.3, 4.1.2; IEPA 1981 pp. 12, 15, Figs. 4, 6a, 6b; Bergstrom and Walker 1956).

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<sup>30</sup> Excavation proceeded to the water table which was approximately 25 ft bgs at that time (IEPA May 1988, pg. 2-45)

<sup>31</sup> Later on the same page (Roux 2001 pg. 2-12) it emerges that the 30-ft thickness applies to the Cahokia plus the uppermost, finer portion of the Henry Fm.; however, it remains unclear whether the uppermost Henry Fm. adds sufficient thickness to explain the inconsistency.

Further characterization of Dead Creek sediments may become available in documents related to the ongoing creek sediment removal action.

### **4.3 Ground-water Hydrology**

This section begins with a brief introduction to concepts and terminology of fluid flow through the subsurface (Sect. 4.3.1), followed by descriptions of the local valley fill aquifer (Sect. 4.3.2) and the bedrock aquifer (Sect. 4.3.3).

#### **4.3.1 Hydrogeologic Concepts and Terminology**

In an uncontaminated subsurface setting, from the surface downward one first encounters an interval where pore space<sup>32</sup> within the soil or rock contains air as well as some water. This is referred to as the zone of aeration or the unsaturated zone, and it contains vadose water. Beneath the unsaturated zone the pore space is completely filled with water. This interval is known as the saturated zone, and it contains ground water. There is a transition interval at the top of the saturated zone where, due to capillary forces, the pore space is partially to fully saturated by water which has been pulled upward by surface tension within the pores; this is known as the capillary zone or capillary fringe. The boundary along the base of the capillary zone is known as the water table. The water table lies at that depth at which water first will enter a well. (Figure 4.1). Due to daily, seasonal, or long term variations in precipitation or ground-water withdrawal (e.g., pumping for water supply), the elevation of the water table generally varies over time.

Water from precipitation and other surface sources recharges or infiltrates the unsaturated zone (Figure 4.1). Flow of vadose water within the unsaturated zone is predominantly downward. Once water reaches the saturated zone flow direction typically becomes predominantly horizontal or subhorizontal. The ground water (as it is now called) flows in the direction of locally descending water table elevation. That direction often is towards a surface water body such as a river or toward a pumping well. A stream segment which receives discharging ground water is a gaining stream. One which recharges the ground water is a losing stream.

The velocity ("velocity" encompasses both speed and direction) of ground-water migration is controlled by the hydraulic conductivity and porosity of the geologic medium and by the hydraulic head gradient, all of which generally vary spatially. Hydraulic conductivity is a measure of the ease of water through-flow and reflects geologic matrix components (e.g., sand has a higher hydraulic conductivity than clay) and depositional or tectonic history (e.g., stratified deposits often have higher hydraulic conductivity along their layers than perpendicular to their layers, and rock fractures usually are aligned in a few specific directions). Ground-water flow speeds vary greatly from many feet per day to less than an inch per year, depending primarily on the hydraulic conductivity of the geologic material.

Ground-water also may migrate vertically downward from the shallowest saturated zone, or water table aquifer, to deeper zones. In most locations there is some component of descending flow; exceptions occur near to surface-discharge features such as streams

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<sup>32</sup> Pore space refers to both intergranular space within unconsolidated sedimentary deposits and fractures within rock.



where flow often has an upward component. The relative (to horizontal) magnitude of the vertical component of ground-water flow varies greatly from site to site depending on the configuration and hydraulic conductivity of the geologic materials and on the strength of the vertical component of hydraulic head.

### **4.3.2 Valley Fill Aquifer**

Because of its thickness and its substantial hydraulic conductivity at depth, the valley fill in the study area hosts a productive aquifer ("valley fill aquifer", a.k.a. "American Bottoms aquifer") which historically has been a major ground-water resource for the East St. Louis area (IEPA 1981 pg. 15). Although the underlying bedrock is fractured and does yield water, the majority of available ground water is present in, and obtained from, the valley fill. The Illinois State Water Survey has characterized the valley fill as sufficiently prolific that chances are "good" of obtaining a well yield in excess of 500 gpm, which is a large quantity. Furthermore, even though the coarsest—and hence most favorable—sediments occur in the bottom 30 to 40 ft of the Henry Fm., shallower sand and gravel lenses are common which also yield significant amounts of water. (IEPA May 1988 pg. 2-34).

The valley fill aquifer is recharged by direct infiltration of precipitation and runoff, by subsurface inflow from the bluff area to the east, and—when head configurations are favorable—by infiltration from Dead Creek and the Mississippi River and inflow from its buried valley channel. Precipitation is believed to be the most significant contributor to ground-water recharge at the Site. Regionally, the constructed system of drainage ditches, levees, and canals protects developed areas but diminishes the volume of water available to recharge the aquifer. (IEPA May 1988 Sect. 2.4; Roux 2001 pp. 2-10, 2-11).

Ground-water usage in the Site vicinity as of 1988 is described in E&E (May 1988 Sect. 2.5). The closest residential usage occurs along Judith Lane, where five private wells existed in 1988. One of the five wells was occasionally used for drinking water, the other four were used exclusively for irrigation. As of the EE/CA—RI/FS nine individual residential wells near to Area 1 were identified, and all were used exclusively for irrigation. Cahokia and Sauget city ordinances currently prohibit use of ground water as potable water. (Roux 2001 pg. 2-11).

*Hydrogeologic Units.* Site investigators have distinguished three hydrogeologic units within the valley fill aquifer (Roux 2001 Sect. 2.1.5.2). These units, from the surface downward, are labeled the Shallow Hydrogeologic Unit ("SHU"), Middle Hydrogeologic Unit ("MHU") and the Deep Hydrogeologic Unit ("DHU"). The SHU contains the Cahokia Alluvium and upper Henry Fm., is approximately 30 ft thick, consists primarily of fine-grained silty sand, and has low to moderate permeability. The MHU contains the upper to middle Henry Fm., is approximately 40 ft thick, is composed of medium to coarse sand which coarsens with depth, and is of relatively high permeability. The DHU contains coarse-grained Henry Fm. sand and gravel (at some locations till and boulders are encountered 10-15 ft above the base), is an estimated 30-40 ft thick, and has high permeability. The lower boundary of the DHU is the bedrock. (IEPA August 3 1987 pg. 2). For interpretive purposes in the EE/CA—RI/FS the three units are defined as 0-30 ft bgs, 30-70 ft bgs, and 70 ft bgs-bedrock (Roux 2001 Sect. 4.2). A thickness of 40 ft is used to approximate the deepest interval (Roux 2001 Sect. 5.2.2).

## Sauget Area 1 – Expert Report on Ground Water Contamination

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Where the static water table lies within shallow, relatively impermeable fine-grained materials of the SHU, the MHU-DHU “aquifer” is said to be “leaky artesian” or “semi-confined” by the SHU “aquitard.” However, where natural conditions (such as the absence of shallow fine-grained material) or substantial local pumpage place the water table within coarser, more permeable materials the aquifer is said to be “unconfined.”

*Hydraulic Conductivity.* Average hydraulic conductivity of the SHU has been estimated from slug tests as approximately  $4.5 \times 10^{-4}$  cm/s (G&M 1986, pg. 21) and  $3.7 \times 10^{-3}$  cm/s (E&E May 1988 pg. 4-53, Table 4-2). A range of values also have been reported for the hydraulic conductivity of the two deeper units of the valley fill aquifer. Based on an uncited 30-year body of testing, Roux (2001 pg. 2-13) states that the MHU has a 33% higher average hydraulic conductivity ( $1.6 \times 10^{-1}$  cm/s) than the DHU ( $1.2 \times 10^{-1}$  cm/s). A pump test of a large-diameter MHU well on the Monsanto property also yielded an estimated hydraulic conductivity of  $1.6 \times 10^{-1}$  cm/s (G&M 1986 pg. 19). On the other hand, slug testing during the SSP yielded hydraulic conductivities for the MHU from  $2.14 \times 10^{-3}$  to  $2.71 \times 10^{-2}$  cm/s and for the DHU from  $1.37 \times 10^{-2}$  to  $1.27 \times 10^{-1}$  cm/s. The slug test results from the SSP trend as would be expected from the site’s increase in grain size with depth.

There is reason to believe that the DHU sands and gravels have a higher hydraulic conductivity than  $1.27 \times 10^{-1}$  cm/s. DHU values may have been underestimated in the SSP due to the limitations of slug testing in high-permeability settings (Zurbuchen and others 2002). Nearby pump tests of production wells at Mobil Oil (at 630 gpm) and at the WGK plant (at 1100 gpm) have yielded vertically averaged hydraulic conductivities of  $1.37 \times 10^{-1}$  and  $1.32 \times 10^{-1}$  cm/s, respectively (Schicht 1965, pp. 12-14, Table 7).<sup>33</sup> Because these two values are the average over a saturated thickness of 73 and 75 ft, respectively, hydraulic conductivity of the deep Henry Fm. sands and gravels are expected to exceed even these values.<sup>34</sup> In addition the inclusion of till, which generally is relatively impermeable, within the thickness of the DHU in some tests may be responsible for underestimation of hydraulic conductivity of the DHU sand and gravel deposits in those tests.

The values of hydraulic conductivity used in the EE/CA—RI/FS are  $1 \times 10^{-2}$  cm/s for the SHU, and  $1 \times 10^{-1}$  cm/s for both the MHU and DHU (Roux 2001).

*Ground-water hydraulic gradient, unpumped.* The Mississippi River is a gaining stream and acts as the discharge boundary to the alluvial aquifer (i.e., to the MHU and the DHU). Beneath Sauget Area 1, under unpumped conditions ground water flow within the alluvial aquifer is generally west-northwest (approximately N60-65°W) toward the Mississippi River. This is inferred from Roux (2001 Figs. 4-29, 4-30, 4-32, 4-33) and is as expected due to the local NNE axis of the Mississippi River. An E&E computer model of the SHU and MHU assigned a comparable average horizontal gradient of N59°W

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<sup>33</sup> Based on 10 aquifer tests and 100 specific capacity tests conducted on industrial, municipal, irrigation and relief wells, hydraulic conductivity values of the regional valley bottom aquifer ranged from  $4.7 \times 10^{-2}$  cm/s to  $1.4 \times 10^{-1}$  cm/s. (Roux 2001 pg. 2-10 citing Ritchey and Schicht 1982).

<sup>34</sup> For the same reason G&M (1986, pp. 22-23) increased the WGK aquifer test result by 50% to  $1.98 \times 10^{-1}$  cm/s.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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(E&E May 1988 Fig. 5-9). The horizontal component of the hydraulic gradient within the alluvial aquifer beneath Area 1 averages approximately 0.001 ft/ft.

The horizontal component of the hydraulic gradient within the SHU generally points west to slightly north of west. Modest spatial and temporal variability in the gradient (e.g., E&E May 1988 Figs. 4-23 through 4-25; Roux 2001 Figs. 4-28, 4-31) may reflect local heterogeneity of SHU materials and transient drainage events. Because of this variability there is some uncertainty in the direction of ground-water flow—and the alignment of consequent shallow contaminant plumes—within the SHU.

The vertical component of the hydraulic gradient within the SHU induces downward flow from the SHU to the MHU; indeed in some locations the head difference from the water table to the MHU is several feet. The vertical gradient within the SHU is an estimated 0.015 ft/ft, which is more than an order of magnitude greater than the horizontal hydraulic gradient of 0.001 ft/ft (E&E May 1988 pg. 5-21). This vertical gradient exists because the MHU drains more easily than the SHU to the Mississippi River. The vertical component of hydraulic gradient between the MHU and DHU is generally small now that industrial pumpage has ceased (the small gradient is due in part to the high permeability of both units) and apparently varies in sign (up or down) as a function of location and season. (E&E May 1988 pp. 5-15, 5-21, 7-18; Roux 2001 pg. 2-13, Sects. 4.2.6, 5.2.3, Figs. 4-28 to 4-33).

The large (approximately two orders of magnitude) contrast in hydraulic conductivity between the SHU and MHU and the approximately 15 times larger vertical hydraulic gradient are conducive to downward flow within the SHU. Indeed, the E&E numerical model of ground-water flow inferred that flow is predominantly vertical within the SHU (E&E May 1988 pg. 5-28). In essence, ground water makes its way a few tens of feet down to the more permeable MHU rather than traveling long horizontal distances within the less permeable SHU, as efficaciously as recharge permits.<sup>35</sup> Given that such vertical flow predominates within the SHU, contaminant plumes may not extend far beyond source areas in the SHU but are expected to reach greater distances in the MHU and DHU. (E&E May 1988 pg. 7-34).

*Ground-water velocity.* Ground-water velocity is a function of hydraulic conductivity, hydraulic gradient, and effective porosity. All of these—but especially hydraulic conductivity—vary spatially, and field measurements do not fully delineate these distributions. Hydraulic gradient also varies temporally, particularly due to historical changes in pumpage. Therefore ground-water velocity is an approximate quantity, and some uncertainty is to be expected.

Available estimates of ground-water velocity are as follows. Flow in the SHU absent local pumpage is at an estimated 19 ft/yr (E&E May 1988 pg. 4-55), 30 ft/yr (Roux 2001 Sect. 5.2.3) or, based on data from adjacent Monsanto, 7.3 ft/yr (G&M 1986 pp. 21-23). Flow in the MHU absent local pumpage is an estimated 300 ft/yr (Roux 2001 Sect. 5.2.3) or, based on data from adjacent Monsanto, 1600 ft/yr (G&M 1986 pp. 21-23). Flow in the

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<sup>35</sup> A similar condition exists within an aquitard between two aquifers: flow is nearly vertical in the aquitard and nearly horizontal within the aquifers. In the current setting, the aquitard is a surficial unit overlying an aquifer, and the degree of vertical flow is affected by the rate of infiltration.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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DHU absent local pumpage is an estimated 300 ft/yr (Roux 2001 Sect. 5.2.3) or, based on data from adjacent Monsanto, 2400 ft/yr (G&M 1986 pp. 21-23).

*Ground-water conditions during period of industrial pumpage.* Historically, ground water was extracted from the valley fill aquifer to provide industrial, drinking water, and irrigation water supply needs. Industrial withdrawal was at one time extensive, peaking in 1962 at more than 35 million gallons per day ("gpd") (24000 gpm). Average daily pumpage from the East St. Louis-Sauget-Cahokia area from 1890-1980 is shown in Figure 4.3. In the Sauget vicinity deep cones of influence (approximately radial depressions in the ground-water table) were induced by the pumpage. G&M (1986, pg. 6) indicates that most or all production wells were screened in the DHU; E&E (May 1988 pp. 4-45, 4-46) states that both the MHU and DHU were pumped at Monsanto. Under natural conditions the water table is about 10 to 15 ft bgs. Due to extraction the water table reportedly was about 25 ft bgs in 1950 (E&E May 1988 pg. 2-45) and up to 60+ ft bgs in 1961 (G&M 1986, Fig. 5). Water table decline from 1900 to November 1961 is an estimated 50 ft (Emmons 1979, pg. 9). Regional potentiometric surface maps for 1900 through 1985 illustrate the development and dissipation of the deep cone of depression in the Sauget vicinity (Schicht and Jones 1962 Figs. 31, 32, 33; Schicht 1965, Figs. 52, 53, 54; G&M 1986 Fig. 5; E&E May 1988 Sect. 4.1.3.2, Figs. 4-21, 4-22). During the period of increasing pumpage the water table descended from within the fine-grained materials to within the coarser-grained deposits (Schicht 1965, pg. 11, Figure 8). Ground-water levels from the pumping centers all the way to the shore were then below the Mississippi River stage, thus inducing flow from the river into the aquifer (Schicht 1965, pg. 41, Tables 23, 25; Schicht and Jones 1962 pg. 15, Figs. 22, 23; G&M 1986 Figs. 5, 6; G&M 1996 Fig. 4; E&E May 1988 pg. 4-45).<sup>36</sup>

The Monsanto Chemical supply wells appear to be at the center of the largest cone of depression, inducing convergent flow towards them from all directions including from the Amax, Cerro, and Midwest Rubber properties (G&M 1986, pg. 7). The maximum decline in the water table at Area 1 Sites, which are offset to the south from the Monsanto property, was about 20 to 30 ft (E&E May 1988, pg. 7-46) corresponding to elevations of about 370 to 380 ft MSL (E&E May 1988 pg. 4-46). Another major pumping center, Monsanto Ranney well #3 adjacent to the Mississippi River west of the northern border of Area 2 Site R (Fig.2.1; IAG0443), was active from 1960 to 1973 and may have affected Area 1 flow direction during that period (E&E May 1988 pp. 4-41, 4-45, 4-46). Within Area 1 the net effect of the Monsanto pumping centers was to redirect ground-water flow toward the north.

As mentioned above, the several Monsanto production wells reportedly are screened in both the MHU and DHU. If much of the total yield was drawn from the deeper zone, this would have induced a downward component of flow from the MHU to the DHU. If so, although the current direction of ground-water flow between the MHU and DHU is variable, the historical gradient and induced flow would have been strongly downward.

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<sup>36</sup> Schicht (1965) provides Mississippi River stage data for only 1965. The shape of the piezometric contours in Schicht (1965, Figs. 52, 53) implies flow from the river to the aquifer on the other two dates.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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Any such a downward gradient would have existed during the periods of active disposal at all of the Area 1 Sites.<sup>37</sup>

Industrial ground-water usage subsequently declined, purportedly as a byproduct of the Clean Water Act (G&M December 22 1987 pg. 6) and/or due to regional deterioration in ground-water quality (G&M 1986 pp. 6-7; E&E May 1988 pg. 2-39). G&M (1986 pg. 8) estimates that not until late 1980 did ground-water flow toward the Mississippi River reestablish itself; E&E (May 1988 pg. 4-45) likewise places this reversal sometime between 1977-1980. In 1988 withdrawal was less than 0.5 million gpd<sup>38</sup>, and as of 2001 no ground water was being pumped in the vicinity of Area 1 for industrial or public water supply purposes (G&M 1986 Figs. 4 through 7; E&E May 1988 pg. 2-39; Roux 2001 pg. 2-11; Solutia 2002 pg. 1-8). With this decline in demand, aided by high river stages and high precipitation, the water table rebounded into the SHU (ISWS 1982 draft figure at IAG1138; Roux 2001 pg. 2-11). Under post-1980 conditions ground water moves predominantly from the Site to the river, although during high river stage flow direction reverses temporarily for up to several thousand feet from the shore (G&M 1986 pp. 13-14). Such reverse flow conditions exist for an estimated 45 days per year—12% of the time—according to G&M (1986 Vol. 2 pg. 3). A computer model of the SHU and MHU inferred that the line of reversal (“zero velocity line”) does not penetrate as far inland as Site G in either hydrogeologic unit (E&E May 1988 Sect. 5.2.6.1).

*Infiltration of Dead Creek waters to the ground-water table.* Water within Dead Creek infiltrates the creek bottom sediments and enters the SHU. E&E observed evidence of such recharge. In 1987 a small ground-water mound was discernable beneath CS-A. Creek water elevation was about 2.5 ft above the ground-water table, this head difference apparently was sustained by the relatively lower permeability creek bed sediments. Even so, some infiltration of CS-A pond waters to the SHU was occurring. This infiltration manifested as an elevated ground-water table at well EE-15 adjacent to the northern pond. (E&E May 1988 pg. 4-52). Historically, infiltration rate likely declined as sewer sediment and wastes accumulated on the creek bed, and then increased again after the creek was dredged.

There is no reason to believe that infiltration through the creek bottom was unique to CS-A. E&E speculated that some infiltration also would occur within CS-B when and where the creek was not dry (E&E May 1988 pg. 4-52). E&E did feel that “evaporation is probably the major cause of water loss in the northern half of CS-B” because infiltration is limited by fine-grained sediments and surficial rubbery waste material downstream of a Midwest Rubber outfall within this section. On the other hand, “water losses due to infiltration may be greater” in the southern half of CS-B due to greater pond depth. (E&E May 1988 pp. 4-23, 4-24). (E&E May 1988 pp. 4-53, 7-19, 7-42).

*Discharge of ground water to Dead Creek.* Conversely, E&E (May 1988, pp. 4-52, 4-53, 7-42) found that ground water did not drain to CS-B (barely). The water table elevation at three nearby wells (EEG-102, -109, and -110) during the highest (May 1987) of three measurement rounds was still 1 to 2 ft below the bottom of the creek. Ground-water

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<sup>37</sup> The last disposal site to receive wastes, Site L, began accepting truck wash effluent in 1971. (Aerial photography indicates earlier excavations—see Sect. 3.1.4).

<sup>38</sup> Industries with active wells in 1988 apparently included Sterling Steel, Big River Zinc, Midwest Rubber, Clayton Chemical, and others of unclear identity (E&E May 1988, Fig. 2-40, pg. 2-39).

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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elevation at these three wells during the 1999-2000 EE/CA—RI/FS field work was lower than the May 1987 levels and thus again lower than the creek bottom (OBG September 2000 Tables 4 through 7). Roux (2001 Sect. 5.2.3) similarly observed that the ground-water elevation in the SHU typically is lower than the surveyed base elevation of the creek segments. Thus CS-B consistently has been found to be a "losing creek." However, should ground-water elevation rise modestly in the future, say due to a period of high rainfall, ground water would discharge to CS-B.

### **4.3.3 Bedrock Aquifer**

No site-specific information is available concerning the hydrogeology of the bedrock. Regional information indicates that the rock does yield ground water. "Where these bedrock formations are located immediately below the unconsolidated material, sufficient groundwater is available for small or medium users. However, because of the abundance of the ground water in the valley fill sand and gravel, the bedrock aquifer is of little significance in the study area." (IEPA May 1988 pg. 2-34; Bruin and Smith 1953; Bergstrom and Walker 1956 pg. 14; Schicht 1965 pg. 8). Nevertheless, Mississippian limestones do yield groundwater from solution channels and joints and are potential sources of ground water in the area (Bergstrom and Walker 1956 pg. 24).

## **5. GROUND-WATER QUALITY**

In this section I discuss the processes which enable migration of waste chemicals to the ground water, selected observed ground-water chemical data, and inferred distributions of selected ground-water contaminants within Area 1.

### **5.1 Processes of Contaminant Transport to Ground Water**

In Area 1 wastes have been released to the environment as free and leaky-containerized (e.g., drummed) liquids and solids. Both liquid and solid wastes may be deposited above or below the ground-water table. Some of the liquid wastes are aqueous (water-based) solutions; the remainder are non-aqueous liquids. This section discusses general transport processes which convey wastes to the ground water.

#### **5.1.1 NAPL**

Non-aqueous phase liquids ("NAPLs") such as fuels, chlorinated hydrocarbon solvents, and other non-aqueous chemical process wastes, if released in sufficient quantity, flow downward through soil to the water table. Both above and below the water table a fraction of the flowing NAPL is retained as immobile "residual" NAPL within the host geologic medium. Such residual may appear as "stains" reported in boring logs. For a given medium the extent of NAPL migration is controlled principally by the released volume, because in order to flow NAPL must satisfy and exceed the residual demand along its path. The residual NAPL above the water table, although immobile, is in intimate contact with infiltrating unsaturated flow (e.g., from rainfall) and dissolves into it. The descending recharging waters thus become contaminated and carry dissolved waste substances to the ground-water table.

If a NAPL is lighter than water ("LNAPL") it floats<sup>39</sup> on the water table and spreads laterally until the release is depleted (Fig. 5.1). LNAPL also vaporizes into the soil gas, creating a vapor plume. This vapor plume spreads vertically and laterally, and may dissolve into the ground water at locations not groundwater-downgradient of the spill.

If a NAPL is denser than water ("DNAPL") and of sufficient volume it continues to sink through the saturated zone until the release is depleted or a barrier such as clay or bedrock is encountered. At such barriers lateral down-slope flow will occur until a break in the barrier is encountered or the release is depleted (Figure 5.2c).

For both LNAPL and DNAPL, to the degree that the NAPL is soluble in water it dissolves into passing ground waters, thus creating a "plume" of contamination (Figure 5.1, Figure 5.2).

Because most waste NAPLs are sparingly soluble in water, they dissolve only gradually; some residual DNAPL may persist for over a hundred years. The consequent "low" (e.g. parts per million as compared to the pure or fractional concentration of the substance in NAPL) concentrations of the waste substances in equilibrated ground water are nevertheless typically of environmental concern. Over time as the more soluble fraction

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<sup>39</sup> Actually, there is a vertical zone of transition from 100% LNAPL to 100% water, but for the purposes of this report it may be ignored.

of a NAPL preferentially dissolves (or the more volatile fraction of a NAPL in the vadose zone volatilizes), the composition of the remaining NAPL shifts and thus the composition of the emanating plume also changes. In summary NAPL creates a persistent source of contamination which generates an evolving contaminant plume within passing ground waters. (Pankow and Cherry 1996).

### **5.1.2 Aqueous Liquids**

Some waste substances are released as aqueous solutions. Certain industrial wastes, wash waters, and sewer wastes consist of or contain such contaminated water. In some cases the contaminated solution may be combined with NAPLs as a mixture or emulsion. The dissolved contaminants may enter the subsurface by direct disposal, by infiltration from spills or ponds, or by leakage from sewers. The contaminants then migrate downward with the solvent water toward the ground-water table. In some settings the release point is below the water table, in which case given sufficient head the waste solution simply enters the aquifer directly. If the volume of release is sufficient, a hydraulic mound may form at or below a release point, inducing ground-water flow radially outward in all directions including against the regional flow.

Migrating solutes also sorb to the geologic medium, so that a portion of the dissolved chemicals in the vadose zone do not initially reach the water table. Later, when relatively clean water (say from precipitation) passes through, these waste substances desorb into solution and are carried to the water table. The same process of exchangeable sorption occurs throughout a ground-water plume, generally delaying ("retarding") migration of the dissolved contaminants in comparison to the migration of the water itself. The magnitude of sorption and retardation depends on properties of the contaminant, of the geologic medium, and to some degree of the other substances in solution.

### **5.1.3 Solids**

Contaminated solids may occur as directly dumped or landfilled contained or uncontained wastes, and as contaminated sediments deposited adjacent to or in a stream channel. In the latter case, the sediments may be particulate matter carried within liquid waste discharged to the stream, natural soil contaminated elsewhere (e.g., at industrial properties) and carried with storm runoff to the stream, or soil contaminated after entering the stream.

Solid wastes may dissolve or desorb into infiltrating vadose water or flowing ground water, and thus create or exacerbate a contaminant plume. In addition, transport of normally low-solubility hydrophobic substances (e.g., PCBs, DDT, some polynuclear aromatic hydrocarbons "PAHs") and heavy metals may be enhanced by facilitating processes such as sorption to tiny organic and inorganic particles (colloids) which are mobile in ground water, and by increased solubility due to cosolvent effects (in both miscible and immiscible solvents). (Huling 1989).

*Note on saturated waste.* Several of the disposal area fill bottoms and the infilled sediment beneath Dead Creek<sup>40</sup> currently lie within the saturated zone (i.e., below the

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<sup>40</sup> Contaminated creek sediments in CS-B extend approximately seven feet (elev. 394 ft msl) below the creek bed, and therefore passing ground water is in contact with creek-derived contaminants even during low water level periods (E&E May 1988 pp. 4-53, 7-19, 7-42).



ground-water table). This facilitates the dissolution of waste materials into the ground water at those locations and likely increases the fraction of the waste material which enters the ground water rather than being depleted by vaporization or chemical degradation. During the period of high industrial pumpage the water table was lower and may not have saturated the waste pits. Nevertheless at that time the infiltration of precipitation through the wastes would have carried contamination to the water table. In the deeper pits the distance to the water table was at most short and through quite permeable materials. Seepage of liquid wastes also would have conveyed NAPLs and substances dissolved within the NAPLs into the ground water.

The deep pits appear to be locations of relatively highly contaminated ground water. Inference of contaminant distributions generally should reflect these potential hot spots whether or not they have been sampled. (For the purposes of this report such spatial resolution was unnecessary).

### **5.2 Background Ground-Water Quality**

Ground water naturally contains dissolved substances, including many of the metals which are of interest to this study. In addition, several industries have operated upgradient (east to ESE) of Area 1 and have released contaminants to the ground water beneath their properties. Known sources exist or have existed at the Mobil, Sterling Steel, and T.J. Moss facilities (Solutia 2000, pp. 3-6 through 3-11; Solutia 2002 Sect. 2.1.2). Wells have been installed at these facilities during environmental investigations distinct from Area 1 activities, and ground-water quality data is available. For instance, certain data on Mobil is collected in Solutia (2000, Appendix 8), on Sterling Steel in Solutia (2000, Appendix 11) and on T.J. Moss in Solutia (2000, Appendix 12). Some summary data for the Moss site is available in E&E (February 1998, pp. US07295-304).<sup>41</sup>

It is appropriate to characterize the ground-water quality immediately upgradient of each Site in order to distinguish Area 1 contaminant releases from incoming natural or anthropogenic ground-water constituents. As a component of the E&E (May 1988) field investigation, four SHU background wells were selected and sampled: EEG-102 upgradient of Site G, EE-04 upgradient of central Site H, EE-20 upgradient of northern Site I, and EEG-108 upgradient of Site L (E&E May 1988 pg. 7-45). I also use these wells as background stations. In the current report well EEG-108 does double-duty as a background well for CS-B. I also use EEG-110 upgradient of central Site G as an additional Site G background well.

During 1999-2000 the EE/CA—RI/FS collected background ground-water data for the same Sites but expanded sampling to all three alluvial hydrostratigraphic units (SHU, MHU, DHU). The deeper samples are important because contaminant migration generally is expected to move downward beneath waste areas and then horizontally in the more permeable MHU and DHU (Section 4.3.2). For Site H the two deeper (MHU and DHU) background samples, herein labeled EE-04\*, were collected 790 ft ENE of EE-04 (an SHU well) because the property owner prohibited access to EE-04 for additional drilling (OBG 2000 Sect. 3.16; Roux 2001 Sect. 3.3.1.8). Although formally

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<sup>41</sup> I have not used data and reports on these upgradient facilities to further evaluate ground-water background conditions, but may do so at a future time.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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linked to EE-04, EE-04\* is distant from it and constitutes a distinct Area 1 background sampling location (Figure 6.1).

At each background well location I use the maximum concentration over depth to represent background concentration. Results from the EE/CA—RI/FS for the chemicals of interest are given in Tables 3.2 through 3.5, 3.8, and 3.9. Those tables show detections of chlorinated benzenes, benzene, ethylbenzene, xylenes, TCE, naphthalene, acenaphthene, benzo(a)anthracene, chrysene, and 2,4-T in various background wells. Heavy metals were detected at concentrations typical of uncontaminated ground waters except for slightly elevated chromium (at four wells, ranging from 40J to 180J ug/l),<sup>42</sup> lead (21 ug/l at EE-04\*/MHU; 22 ug/l at EE-20/DHU), molybdenum (28 ug/l at EE-04\*/MHU; 49 ug/l at EE-20/DHU), nickel (180 ug/l at EE-04\*/SHU; 62 ug/l at EE-04\*/MHU; 56 ug/l at EE-20/DHU), and vanadium (54 ug/l at EE-04\*/MHU; 50 ug/l at EE-20/DHU). Finally, background sample EE-04\*/SHU is notable for its elevated potassium (170 mg/l, tied for highest of all wells in the EE/CA—RI/FS).

Based on the observed water quality at locations EE-04, EE-04\*, EE-20, EEG-102, EEG-108 and EEG-110 in both the E&E and EE/CA—RI/FS studies, ground water approaching the Area 1 Sites is not devoid of contaminants. However, it is relatively clean compared to that beneath most of the Area 1 disposal sites. Furthermore, where detected background concentrations are in the MHU and DHU and detected concentrations beneath source areas are in the SHU (a frequent occurrence), the likelihood of background interference remains quite small. I have found that the observed background concentrations generally permit me to confidently make inferences on releases from the disposal Sites.

*Note on E&E background ground-water quality data.* For purposes of inferring releases in this report, the United States has instructed me to rely principally upon ground-water quality data developed during the EE/CA—RI/FS. For completeness I also have examined the background results from the 1987 E&E sampling events (E&E May 1988, App. D). Only the SHU was sampled at that time. The E&E background well samples detected the following organic chemicals of interest:

Site G: EEG-102 — 36 ug/l chlorobenzene  
          EEG-110 — 1 ug/l benzene, 6 ug/l chlorobenzene, 30 ug/l 4-chloroaniline  
Site H: EE-04 — no organics  
Site I: EE-20 — no organics  
Site L: EEG-108 — 1 ug/l benzene, 1 ug/l chlorobenzene.

If these data had been used to develop ground-water background concentrations in this report, the background concentrations would have increased at Site G for chlorobenzene (from 11 to 36 ug/l), benzene (from nd(5) to 1 ug/l), and 4-chloroaniline (from nd(20) to 30 ug/l). At Sites H and I no change would have occurred. At Site L the background concentration would have increased very modestly for benzene (from 0.99J to 1 ug/l) and chlorobenzene (from nd(5) to 1 ug/l). With respect to metals of interest, in no case was an E&E concentration greater than that detected in the EE/CA—RI/FS for each of

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<sup>42</sup> The standard notation is used herein to qualify analytical results: J=estimated, D=diluted, nd(x)=not detected at a detection limit of x. Standard abbreviations are used for units: mg=milligram, ug=microgram, kg=kilogram, l=liter, ppm=parts per million.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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the five background wells. (E&E May 1988 pp. 7-33 to 7-35, App. D). If the E&E ground-water background had been used it would not have elicited any changes in the release inferences of Table 3.2 through Table 3.9.

*Note on Site G background water quality.* Because Site G is downgradient of Sites H, L and CS-B, its upgradient ground water may contain contamination from one or more of those sites. Indeed, when sampled during the EE/CA—RIFS the Site G SHU background wells EEG-102 and EEG-110 contained the following chemicals of interest: 79 ug/l chlorinated benzenes, 9.5J ug/l molybdenum, 150 ug/l nickel, and 540 ug/l zinc. Somewhat similar results were obtained for the same wells during the E&E study: 36 ug/l chlorobenzene, 30 ug/l 4-chloroaniline, 111 ug/l nickel, and 53 ug/l zinc.

In this report the EEG-102 and EEG-110 results are used to characterize Site G SHU background water quality. Only SHU information is available from these stations (in both studies) whereas much of the horizontal contaminant migration at Site G is expected to occur in the deeper units. Therefore, these SHU background data provide an incomplete picture of the water quality approaching Site G. The upgradient station for Site L, EEG-108, also is upgradient of Site G and was sampled in all three alluvial hydrostratigraphic units. Of course it does not intercept any releases from Site L, but it does reflect whether other upgradient facilities or activities may have contaminated oncoming ground waters. At EEG-108 the only detected contaminants are at relatively low concentrations: benzene (0.99J ug/l), TCE (0.57J ug/l), and several metals (Table 3.5). Therefore activities upgradient of Area 1 do not appear to complicate interpretation of releases at Site G.

The effect of releases from Site L on Site G background are more problematic. As discussed in Sections 5.3.4 and 6.2.1, Site L contributed significant contamination to the SHU (at SHU well EEG-109: benzene, chlorobenzene, chloroform, 4-methyl-2-pentanone, chlorinated and methylated phenols, 4-chloroaniline, and [E&E data only] toluene and 2-nitrophenol). This contamination is expected to have migrated into the MHU and subsequently to have affected the aquifer within the southern portion of Site G. Absent any MHU or DHU station between Sites L and G, it is a challenge to discriminate the source of contaminants found at both Site L and in the MHU and DHU beneath and beyond Site G. However, as demonstrated by the relatively low number and levels of contaminants in intervening SHU well EEG-102 (11 ug/l chlorobenzene, 58 ug/l 1,2-dichlorobenzene, 9.5J ug/l molybdenum), contamination within the SHU in Site G is attributable to Site G releases. Therefore any ambiguity in the origin of contaminants in the MHU or DHU beneath Site G is not important to the release opinions of this report.

### **5.3 Area 1 Ground-Water Quality**

In this section I address the water quality of the ground water beneath and down-gradient of Sites G, H, I, L, M, N, CS-A, CS-B, and the sewer lines within Area 1. Attention is restricted to the "chemicals of interest" to this report. As instructed by the US, I rely principally on data obtained during the EE/CA—RI/FS.

*Beneath Source Areas.* The primary purpose of this report is to identify chemicals released to ground water at the Area 1 Sites. Data from all four hydrostratigraphic units were examined, and SHU wells located within or immediately adjacent to the Sites proved to contain the highest concentrations and the broadest array of substances. This

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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is as expected because of the horizontal and vertical proximity of the SHU samples to the sources. As a result, much of what I conclude in Section 6 concerning releases stems from SHU data.

But one should not infer that the MHU and DHU are relatively uncontaminated beneath the source areas. There is almost no water quality data for the MHU and DHU beneath the source areas: samples have been collected from only two such stations (H-S1, I-S4). At other locations the valley fill aquifer beneath the source areas can be characterized only indirectly by samples from below its base (three bedrock wells BR-G, BG-H, BR-I) and from immediately downgradient (GHL-S1, H-S1, I-S1). One finds that some of these stations have very high concentrations of chemicals of interest, particularly chlorobenzenes. Some of the bedrock samples indicate the likely presence of DNAPL (Roux 2001 App. D). Residual and pooled DNAPL beneath the source areas (e.g., on till, or on the bedrock surface) will generate dissolved contaminant plumes beneath and downgradient of the source areas within the valley fill aquifer.

At all of the Sites it is expected (and where examined, it is found) that interred waste concentrations vary widely spatially at the sub-Site scale. Therefore at the sub-Site scale ground-water contaminant concentrations also are expected to vary widely within and adjacent to the Sites. "It is probable that the contaminant plumes emanating from sources...create discreet plumes or fingers" (IEPA June 30 1987, pg. 3). It is unlikely that the relatively few ground-water sampling stations have intercepted the highest concentrations emerging from each Site. This is true for both the SHU and the deeper units. For purposes of identifying and characterizing chemicals of interest released to ground water at each Site it is reasonable to use the maximum observed concentration over the Site wells, and that is the approach taken in this section.

*Downgradient of Source Areas.* A secondary purpose of this report is to examine the extent of contaminant migration from the Area 1 Sites. There are only a few downgradient ground-water stations which sampled the MHU and DHU, and most of these stations are offset from expected paths of migration from the Sites (Section 6.1). As a result the data do not permit meaningful inference of the extent or severity of migration from the Sites. Only "lower-bound" conclusions can be drawn from the data (e.g., "contamination has gone at least so far, and with at least such a concentration"). In Section 6 I discuss this point and illustrate it with a diagram for chlorobenzene. I otherwise do not present results or opinions concerning downgradient contaminant migration of the chemicals of interest.

### **5.3.1 Site G**

Chemicals of interest were detected in all four hydrostratigraphic units beneath, and three units downgradient of, Site G (bedrock was not monitored downgradient). For each chemical and each hydrostratigraphic unit the maximum detected concentration is shown in Table 3.2. Almost all of the Site maxima were encountered at SHU well EEG-107 which is screened in sand below waste materials (E&E May 1988 pg. 7-33, App. D). EEG-107 contains benzene (37000D ug/l), chlorobenzene (4300D ug/l), toluene (8500D ug/l), 4-chloroaniline (23000D ug/l), 2,4-dichlorophenol (3600 ug/l), 3- or 4-methylphenol (2400 ug/l), naphthalene (2100 ug/l), phenol (14000D ug/l), and pentachlorophenol (2000 ug/l), as well as numerous other organic chemicals of interest at less than 1000

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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ug/l.<sup>43</sup> Vanadium (330 ug/l) also is elevated at EEG-107, as is molybdenum (450 ug/l) at EE-05.

Well EE-11 is located midway along the north border of Site G (E&E May 1988 Fig. 3-7) but was not sampled during the EE/CA—RI/FS. As a result EE-11 does not appear in the EE/CA-RI/FS figures or concentration tables. In 1987 EE-11 was sampled and found to contain numerous organic compounds. Reported concentrations did not imply that NAPLs of the quantitated substances necessarily were present, but did indicate substantial contamination of the ground water. 4-chloroaniline (15000E ug/l) and chlorobenzene (2500 ug/l) were the two most concentrated substances in that sample. (E&E May 1988 App. D).

No Site G maxima were detected within the MHU although several compounds were present. The DHU contains the highest Site G concentrations of chromium (570 ug/l), lead (45 ug/l), and nickel (150 ug/l); however, the last equals the background nickel concentration from EEG-110.

PCB's were detected in all four hydrostratigraphic units, with the maximum in the bedrock well BR-G (73 ug/l). Several additional compounds were found at high levels in BR-G including the insecticide 2,4-D (440D ug/l), the herbicide MCPP (2500J ug/l), and the VOC 1,2,4-trichlorobenzene (87000D ug/l).

### **5.3.2 Site H**

Chemicals of interest were detected in all four hydrostratigraphic units beneath, and three downgradient of, Site H (bedrock was not monitored downgradient). For each chemical and each unit the maximum detected concentration is shown in Table 3.3. Almost all Site maxima were encountered at SHU wells EE-01 and EE-02. EE-01 is screened in fine-medium sand beneath approximately 17 ft of waste. EE-02 is screened in very fine sand; no overlying waste is logged. Organic chemicals of interest exceeding 1000 ug/l in the SHU include benzene, chlorobenzene, ethylbenzene, toluene, 4-chloroaniline, 1,4-dichlorobenzene, naphthalene, and pentachlorophenol. Several other organics also are present. Metals molybdenum and zinc peak at SHU well EEG-110 which is downgradient of Site H and is screened in fine to medium sand. (E&E May 1988 App. B).

The MHU contains high concentrations of chlorobenzenes (up to 14000 ug/l), MCPP (3600J ug/l), total PCBs (9.82 ug/l) and nickel (720J ug/l). DHU contaminants are very similar, including two compounds above 1000 ug/l: chlorobenzenes (up to 2400D ug/l) and MCPP (4400D ug/l), total PCBs (12 ug/l), zinc (1000 ug/l), and additional substances at lower concentrations.

The single bedrock well in Site H, BR-H, contains several organic compounds; 1,2,4-trichlorobenzene (600D ug/l) is the most concentrated. Nickel (9600 ug/l) is elevated compared to the maximum nickel background concentration of 180 ug/l at EE-04.

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<sup>43</sup> Benzoic acid, which is not a chemical of interest and was not assayed in the EE/CA—RI/FS, was the most concentrated organic substance detected at EEG-107 in the 1987 E&E study.

### 5.3.3 Site I

Chemicals of interest were detected in all four hydrostratigraphic units beneath, and *three downgradient of, Site I (bedrock was not monitored downgradient)*. For each chemical and each hydrostratigraphic unit the maximum detected concentration is shown in Table 3.4. Site I maxima for most substances were encountered in the bedrock well sample. Very high concentrations also were detected in SHU wells EE-14 screened within the historical north pit of Site I (E&E May 1988 pg. 7-34) and I-S1 downgradient of Site I. Organic chemicals of interest exceeding 1000 ug/l in the SHU include chlorobenzene, 1,2-dichloroethene, 4-chloroaniline, and 1,4-dichlorobenzene. Several other organics also are present. Metals nickel (7800 ug/l) and zinc (33000J ug/l) are quite elevated in shallow samples from I-S2 which was located about 700 ft west of Site I.

The MHU also contains high concentrations of chlorobenzenes (up to 20000 ug/l), 1,2-dichloroethene (1400 ug/l) and 4-chloroaniline (1700D ug/l). DHU contaminants are similar, including chlorobenzenes (up to 3400D ug/l), naphthalene (1400D ug/l), MCP (640J ug/l), lead (4100 ug/l), zinc (6300J ug/l) and additional substances.

The bedrock well in Site I, BR-I, contains the highest concentrations of total SVOCs (1300000 ug/l, or 0.13%) of all wells analyzed in the EE/CA—RI/FS. Nearly half of the contaminant mass in the sample is 1,2,4-trichlorobenzene, which at 1100 mg/l exceeds its solubility in pure water (300 mg/l; Roux 2001 App. D, Table 1) implying the presence of DNAPL. In addition to other chlorobenzenes, substances exceeding 1000 ug/l in the bedrock water sample include 2,4-dichlorophenol (2400 ug/l), 2,4,6-trichlorophenol (1700 ug/l), naphthalene (5800 ug/l), the herbicide MCP (18000JD ug/l), and total PCBs (15750 ug/l).

It is possible that CS-A, rather than the waste deposits of Site I, introduced substances detected at ground-water stations west (downgradient) of CS-A. Therefore in Table 3.4 where a maximum is from a station downgradient of CS-A, I also show the maximum of stations upgradient of CS-A. This is possible only for the SHU, because all MHU and DHU samples (except relatively uncontaminated I-S4) are from downgradient of CS-A. Recognizing that BR-I is upgradient of CS-A, from Table 3.4 it can be seen that only two detected chemicals of interest were not found in ground water upgradient of CS-A: vinyl chloride and 4,4'-DDT. Therefore it is clear that the Site I waste deposits are a source of the full spectrum of contaminants in the Site I ground water.

In evaluation of Site I ground-water samples, I have used EE-04\* as a second background sample (along with EE-20). EE-04\* was sampled as a substitute MHU/DHU location for EE-04 which is upgradient of Site H. However, due to access restrictions EE-04\* was placed 790 ft ENE of EE-04, in a location which I interpret to be upgradient of Site I.

### 5.3.4 Site L

Only one well, SHU station EEG-109, monitors potential releases from Site L. EEG-109 is located on a thin strip of unexcavated soil between a former pit at Site L and CS-B (Figure 6.1). EEG-109 was characterized in 1981 as "the most polluted" of the 12 wells sampled in that program; in fact during drilling of EEG-109 the driller and driller's

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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assistant became nauseated by the fumes escaping the subsurface. (IEPA 1981 pp. 34, 38, boring log at US03422-23; E&E May 1988, pg. L-3).

Chemicals of interest have been detected in EEG-109 and are tabulated in Table 3.5. Organic compounds above 10 ug/l include chloroform, 4-methyl-2-pentanone, 4-chloroaniline, 2-chlorophenol, 2,4-dichlorophenol, and naphthalene. The herbicides 2,4-D and 2,4,5-T are elevated. Nickel (180000 ug/l) is at the highest concentration detected in Area 1. No PCBs or PAHs are detected. In addition, the pH (an inverse measure of acidity) at EEG-109 is consistently quite low (4.1 in 1981, 4.7 in 1999), which along with other elevated indices such as ammonia, chemical oxygen demand, and sulfate reflects grossly contaminated ground water (IEPA 1981 Table 4b; OBG Sept. 2000 Vol. 1 part 2, pg. 97A-8). The EEG-109 ground water quality is relatively distinct from that in other stations in Area 1 with respect to these parameters and also in its near absence of chlorinated benzenes.

### **5.3.5 Site M**

No ground-water monitoring well unambiguously reflects conditions downgradient of Site M. This is so both because CS-B is immediately adjacent to Site M, potentially adding to releases between Site M and some stations, and because the candidate stations EEG-111, EEG-105, SGW-S1, TS-S1, SW-S2 and SW-S3 are slightly outside the inferred shadow of Site M (Section 6.1, Figure 6.1). In addition, releases from Site M likely declined after CS-B (to which it is hydraulically connected) ceased to serve as a surge pond for the Village sewer system in 1968. Therefore the recent ground-water sampling results, where they do indicate ground-water contamination, likely understate former releases. Likewise where a constituent is not detected in recent data, the ground-water data is not conclusive concerning past releases (Section 6.2.2).

SGW-S1, a three-depth (15, 20, 40 ft bgs) 1999 Geoprobe sampling station, was located on the upgradient (SE) edge of the pond at Site M. MHU well TS-S1 was placed at the same location, pumped for 24 hours, and sampled at 0, 12, and 24 hr. Although upgradient, these stations may be influenced by Site M due to possible hydraulic mounding beneath the pond. In addition, after 12 and 24 hr of pumping TS-S1 may have drawn some ground water from beneath the pond. The maxima for chemicals of interest at these two stations are shown on Table 3.6. Detected contaminants included PCBs, PAHs, and 1,4-dichlorobenzene.

The maxima for the remaining ground-water stations which may reflect Site M releases, EEG-105, SW-S2, and SW-S3, are shown in Table 3.9. These stations also may reflect releases from CS-B, and are described in Section 5.3.8.

### **5.3.6 Site N**

No groundwater samples were collected beneath or downgradient of Site N, notwithstanding the presence of drums and waste materials located within Site N. Consequently no data are available to assess groundwater contamination.

### **5.3.7 CS-A**

Ground-water beneath and downgradient of CS-A also is downgradient of Site I. Therefore it is problematic to identify a water quality sampling station which

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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unambiguously characterizes releases from CS-A. However, well EE-15 is known to reflect a water level rise which is attributed to leakage from CS-A. This suggests that the well also intercepts ground-water flow from CS-A to at least some degree. Water quality data is available for EE-15 from 1987 and 1999, and I rely on it along with sediment data to indicate compounds likely released from CS-A (Section 6.2.2).

In at least one of its two samples EE-15 contained the VOCs benzene (also in a background well), chlorobenzene, 1,2-dichloroethene, trichloroethene, and vinyl chloride; and the SVOCs 4-chloroaniline, 2-chlorophenol, dichlorobenzenes, and pentachlorophenol (Table 3.8).

### **5.3.8 CS-B**

It is problematic to identify ground-water quality stations potentially indicative of releases from the most contaminated portion of CS-B. That reach, approximately the upper third of CS-B nearest Queeny Ave., is downgradient of waste disposal Sites H and L and adjacent to Site G. Therefore ground-water sampling stations downgradient of this portion of CS-B also are downgradient of one or more of these Sites, are affected by the Sites, and hence are not useful to discriminate releases from CS-B. The chemicals found in CS-B sediments are the same as those in the land disposal sites, precluding fingerprinting of creek releases. As a result I did not identify any ground-water stations useful for confirming releases from the upper third of CS-B.

Several ground-water sampling stations exist downgradient of the central third of CS-B, and these stations I infer to be outside the shadows of the known waste disposal Sites (Figure 6.1). Stations EEG-103, EEG-104 and SW-S1 are those least likely to have been affected by Sites G, H, L or M. The first two stations sampled the SHU only; the last sampled from ten depths (14 ft to 101 ft bgs) spanning all three alluvial hydrostratigraphic units. EEG-103 is immediately adjacent to CS-B; EEG-104 and SW-S1 are about 450 ft downgradient of CS-B (Figure 6.1). Table 3.9 shows the 1999 EE/CA—RI/FS sampling results for these stations. EEG-103 detected no chemicals of interest (none above background for metals); EEG-104 detected a low level of toluene (0.54J ug/l).<sup>44</sup> Station SW-S1 was sampled only during the EE/CA—RI/FS. Chemicals of interest were detected at SW-S1 including chlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, 1,2-dichloroethene, toluene, pentachlorophenol, phenanthrene, and 2,4-D. I use EEG-108 to set background metals concentrations for this area.

The downstream third of CS-B includes Site M. Ground-water sampling stations in this vicinity are EEG-105 adjacent to the creek, SW-S2 350 ft from the creek and SW-S3 430 ft from the creek (Figure 6.1). All three were sampled only during the EE/CA—RI/FS, and results are shown in Table 3.9. EEG-105 contained only pentachlorophenol (0.097J ug/l). SW-S2, sampled at 10 depths, detected chlorobenzene, 1,2-dichloroethene, 2-

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<sup>44</sup> The 1987 E&E sample from EEG-103 contained chloroform (9 ug/l), chlorobenzene (5 ug/l), PCBs (Aroclor 1260 at 14J ug/l), and mercury (2.1 ug/l); that from EEG-104 contained benzene (1J ug/l), chloroform (3J ug/l), toluene (3J ug/l), chlorobenzene (5 ug/l), and naphthalene (8J ug/l).



## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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chlorophenol, 1,2-dichlorobenzene, 1,4-dichlorobenzene, pentachlorophenol, PCBs, chromium, and nickel. SW-S3, also sampled at 10 depths, detected chlorobenzene, 1,2-dichloroethene, toluene, xylenes, 4-chloroaniline, 1,2-dichlorobenzene, 1,4-dichlorobenzene, pentachlorophenol, 2,4-D and PCBs. In these results I have omitted detections of trichloroethene and benzene due to their presence at background station EEG-108 (Table 3.9).

## **6. OPINIONS**

In this section opinions are numbered consecutively, and explanations or comments follow them. Section 6.1 considers the spatial distribution of ground-water contamination downgradient of Area 1 sources within Area 1 (i.e., east of Rt. 3). Section 6.2 addresses the releases from potential sources within Area 1.

### **6.1 Spatial Distribution of Ground-water Contamination**

- (1) Contaminated ground water exists over the entire cross-section of the valley aquifer from the surface to within the bedrock greater than 100 ft bgs. This vertical distribution is likely due to a combination of downward vertical migration of dissolved contamination (from SHU to MHU and—especially historically—from MHU to DHU) and leaching from submerged residual DNAPL.
- (2) The monitoring well network downgradient of the disposal areas is inadequate to delineate Area 1 ground-water contamination. One can establish lower bounds on the severity and horizontal extent of contamination, but cannot reliably estimate plume boundaries or average or peak concentrations.

At most of the Sites ground-water sampling station locations are adequate to determine whether or not a release to ground water has occurred and to identify released chemicals of interest. This is so because releases affect SHU wells within or near to a Site, and a number of appropriately located SHU wells were installed by IEPA and sampled during multiple investigations including the EE/CA—RI/FS. On the other hand there are few sampling stations available to characterize the spatial distribution of ground-water contamination downgradient of the Sites. Only the EE/CA—RI/FS obtained samples from the deeper (MHU, DHU) hydrostratigraphic units within which substantial migration is likely, and most of those sampled locations are offset from anticipated contaminant plumes from the Sites. Therefore the available downgradient water quality data cannot resolve the extent or severity of contaminant migration except to establish "lower bounds" (e.g., contamination migrated at least so far, with at least such a concentration).

To illustrate this point I have sketched the inferred direction of ground-water flow, which is approximately N60°W (Section 4.3.2), on a map showing Sites G, H, I, L, and M (Figure 6.1). The figure shows lines extending at N60°W from the edges of the Sites; the area within these lines downgradient of each site is a downgradient "shadow" of that site. Although variations in flow direction and dispersion can spread plumes laterally beyond the edge of such a shadow, the core of a plume and the associated highest concentrations are expected to occur within the shadow. Moreover, the strongest sources are unlikely to be at the edges of the Sites or, therefore, at the edges of the shadow (excepting the boundary between Sites H and I). With this understanding of Figure 6.1, I next discuss downgradient water quality for Sites G, H, and L, and then for Site I.

*Sites G, H, L.* The downgradient aquifer stations GHL-S2 and GHL-S3 are outside of, or in the fringe of, the Site G shadow. The same is true for these wells with respect to the Site L shadow. GHL-S1 is the only MHU/DHU station directly downgradient of the

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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interior of Sites G and L. However, aerial photography and site geophysics did not identify disposal other than surface debris in the SW portion of Site G, which is the part of Site G upgradient of GHL-S1 (Section 3.1.1). Furthermore there is no station downgradient of source area well EEG-107, and EEG-107 ranks as the most highly contaminated location in Site G based on SHU water quality data. Similarly, there is no station downgradient of substantially contaminated source area well EE-11 (which was not sampled during the EE/CA—RI/FS). In summary, there is no MHU/DHU well appropriately located to reflect the core of the contaminant plume emanating from Site G.

There is no downgradient MHU/DHU station available to characterize any plume emanating from Site H. All three downgradient GHL stations lie outside of the Site H shadow.

Therefore I conclude that the sampling network likely missed the more concentrated portions of the multiple contaminant plumes emanating from Sites G, H, and L into the MHU and DHU. As a result the existing data bias-low inferred plume diagrams. Contamination which is detected by this network lies along the southern fringe of the Site G (and perhaps Site L) shadow and therefore represents only a lower bound on the contaminants and concentrations likely present in the unmonitored core of that Site's plume(s).

*Site I.* There are three downgradient stations associated with Site I. Based on aerial photo interpretation in IEPA (1981)<sup>45</sup>, stations I-S2 and I-S3 lie on—or just outside of—the northern edge of the downgradient shadow from the historical pit spanning Sites H and I. Thus these stations are offset from the expected plume<sup>46</sup> path from that pit. As a result, to the extent that these substantially contaminated stations characterize releases from that particular disposal pit at all, it is likely that they understate concentrations within the core of that plume. It is also possible that stations I-S2 and I-S3 are too far north to intercept contamination from the historical spanning pit, in which case there is no information on downgradient ground-water contamination created by wastes within that pit.

The Site I downgradient wells do demonstrate that Site I has created a substantial contaminant plume in the MHU/DHU aquifer. At least I-S1, and perhaps all three of the I-transect stations, reflect wastes from central Site I (I-S2 and I-S3 may reflect the historical spanning pit). The most contaminated of the three transect stations is I-S1. I-S2 and I-S3 are not directly downgradient of I-S1 and therefore do not measure the maximum strength of the plume downgradient of I-S1.<sup>47</sup> As discussed in Section 5.3.3,

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<sup>45</sup> As of the writing of this report I have been provided the text but not the graphics of ERI (2002). When that material is made available I may revise these inferences.

<sup>46</sup> SHU well EE-12 within the historical pit contained 680 ug/l benzene, 1400D ug/l chlorobenzene, 1400D 4-chloroaniline, and other chemicals of interest at lesser concentrations, so a plume is expected.

<sup>47</sup> Groundwater Services Inc. (May 2001) also recognizes that I-S2 and I-S3 are offset from the flow line through I-S1. But in using a flow direction which is more westerly (N72°W) than I have inferred, GSI represents the stations as more aligned than I believe is justified. A more northerly flow direction would increase the estimated ultimate length of the plume in the GSI work, other assumptions being unchanged.

## ***Sauget Area 1 – Expert Report on Ground Water Contamination***

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concentrations of several chemicals of interest are quite elevated in the MHU and/or DHU at these three stations. Based on samples from the most distant station, I-S3, contamination from Site I has migrated at least 1400 ft, using central Site I as a starting point. Moreover, the high concentrations at I-S3, age of the source, and ambient ground-water flow imply that detectable contamination extends within the Site I plume(s) beyond the western boundary of Area 1. In summary it appears that there is no station downgradient of the most contaminated portion of Site I, and available data (I-S2 and I-S3) likely understate the severity of contamination downgradient of Site I and exiting Area 1.

To illustrate the ambiguity of Area 1 downgradient contaminant distribution I have prepared Figure 6.2, a sketch of inferred chlorobenzene concentration (maximum over depth within the alluvial aquifer). This sketch is to be compared with Figure 6.3 which was apparently created by Solutia contractor Groundwater Services Inc. ("GSI").

In Figure 6.2 the orientation of the inferred 100 ug/l boundaries is more northerly than in Figure 6.3, and the width of the >100 ug/l plume leaving Area 1 is wider than in Figure 6.3.<sup>48</sup> In addition Figure 6.2 adds a >100 ug/l plume from Site M which is suggested by adjacent lower concentrations but is not confirmed by any stations within its core. Finally, Figure 6.2 infers that concentrations exceeding 20000 ug/l chlorobenzene exit Area 1, which I suspect is more concentrated than that envisioned in the EE/CA—RI/FS.<sup>49</sup>

My point is not to claim that one figure is incorrect, but rather to show that available data permit a wide range of reasonable inferences concerning downgradient concentrations. I do believe, however, that the "kink" in the southern boundary of the chlorobenzene plume shown in Figure 6.3 is an artifact of relying on an SHU station (EEG-112, 2.8J ug/l). MHU and DHU concentrations are expected to exceed SHU concentrations in downgradient areas; an interpolation of "maximum over depth" should give little weight to a low SHU concentration downgradient of the source areas. I also believe that the more northerly path of plumes in Figure 6.2 better reflects site hydraulic data.

*Note on Impact of Historical Pumpage on Contaminant Distribution.* The historical pumpage at industrial properties within and adjacent to Area 1 diverted ground-water flow from its natural riverward course. Instead, flow within the MHU and DHU was drawn towards Monsanto. Downward flow from the SHU to the MHU was intensified, flow from the MHU to the DHU also may have increased, and directions of flow shifted over the years with changes in the yields of various production wells. Addition of the Monsanto Ranney well near the Mississippi River also may have altered Area 1 flow direction somewhat during 1960-1973. (Section 4.3.2). The net result of these variations in flow

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<sup>48</sup> If any MHU/DHU monitoring wells exist in Area 2 downgradient of, and close to, Area 1, they may reduce uncertainty in the interpreted Area 1 plume. Review of Area 2 ground-water data was outside the scope of this report.

<sup>49</sup> Figure 6.3 does not indicate a maximum concentration in ground water exiting Area 1, but Solutia does address this matter for chlorobenzene and other compounds in its calculations of estimated class 1 plume length (GSI 2001). In particular, those calculations rely strongly upon station I-S3 to characterize the concentrations exiting Area 1, and therefore to calibrate the plume model. I anticipate that if the model were to use higher concentrations as suggested by Figure 6.2, the calculated plume lengths would be significantly longer.

direction was to spread contaminants over a broader horizontal and vertical swath than would otherwise have occurred.

Since approximately the late 1970s, with the reestablishment of riverward flow, the contaminant plumes emanating from Area 1 Sites likely have become more compact and linear than formerly. Based on estimated ground-water velocities (Section 4.3.2), it is likely that the available aquifer ground-water quality data (SHU since 1981, mostly since 1986; MHU and DHU in 1999) reflect post-1980 age ground waters. However, this may not be the case for the least mobile, sporadically detected contaminants at the most distant wells (e.g., PCBs, PAHs at I-S3). Such contaminants may have been in transit over decades including initially along a more northerly path induced by industrial pumpage.

## **6.2 Sources of Ground-water Contamination**

This section provides opinions and rationale concerning releases of chemicals of interest to ground water within Area 1. The potential releases are addressed first from the land disposal Sites (G, H, I, L, N) (Section 6.2.1), then from the surface waters (CS-A, CS-B, Site M) (Section 6.2.2), and finally from the municipal and industrial sewers (Section 6.2.3).

### **6.2.1 Land Disposal Sites**

*General Bases of Opinions:* My opinions concerning releases from the Area 1 land disposal sites are based on the following:

- Information on historical usage of the areas for disposal, including from interpreted aerial photographs and other sources, as described or cited in Section 3.1;

- Physical evidence of wastes within the disposal areas, including visual observations of surface and subsurface waste materials, geophysical evidence of disposal, discoloration of soils, and discoloration and NAPL observed in ground-water samples;

- Chemical evidence of wastes within the disposal areas, including waste and soil analytical results and waste and soil leachate (TCLP) analytical results, as described or cited in Section 3.1;

- Inferred direction of ground-water flow (Section 4.3.2);

- Background ground-water concentrations of chemicals of interest, using data for wells described in Section 5.2; and

- Migration of contaminants by recognized mechanisms as described in Section 5.1 and the hydrogeologic literature.

I conclude that a substance was released to the ground water at a land disposal area if the substance is present in the disposal area wastes (concluded from any analysis) and is detected in the ground water beneath or downgradient of the disposal area. For those substances which are present in background samples for a disposal area, I require that the maximum detected concentration beneath or downgradient of the disposal area be at least 10 times the largest detected background concentration. Although this does not completely eliminate the possibility of a false positive, it is a conservative approach. Furthermore, where detected background concentrations are in the MHU and DHU and detected concentrations beneath source areas are in SHU samples, the likelihood of a false positive is even smaller.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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For some chemicals the data was inconclusive with respect to my release criteria. This included situations where wastes were not analyzed for the substance, but ground water was (carbazole, MCP, 2,4,5-T, molybdenum). Although no waste was analyzed for a substance, its presence at concentrations above background strongly suggests that it was released at the site; I indicate these situations by "Y" in my tables of inferences. There were also three more ambiguous situations: detected in ground water but not in waste or soil (indicated by "?" in my tables of inferences); concentration less than 10 times background (indicated by "B"), and concentration less than the detection limit of a not-detected background (indicated by "??"). If any of these ambiguous results prove to be of importance to the litigation, I may examine additional information to better resolve them. Finally, there are no ground-water stations at or downgradient of Site N, which therefore cannot be assessed according to these criteria.

*A Note on Less Mobile Contaminants.* Some of the chemicals of interest, particularly PCBs and PAHs (excluding naphthalene) are characterized as having very low mobility in ground water. This is due primarily to their very low water solubility and very high tendency to sorb to organic substrates. (E&E May 1988 Sect. 6.3, Tables 6-7, 6-8). Once introduced into a ground-water system<sup>50</sup> these compounds typically do not migrate far from the source or do so at very low concentrations. However, the principal concern in this report is release to the ground-water, not dissolved strength or distance of migration. In that respect these compounds are not remarkable, because they are capable of entering the ground water at detectable concentrations. Moreover, site data indicate that certain PCBs and PAHs have migrated downgradient hundreds to over 1000 ft from source areas. I discuss the evidence concerning both the source area releases and downgradient migration of PCBs and PAHs in the following paragraphs.

**PCBs.** PCBs have been detected at relatively high concentrations within source area ground waters at Site G (73 ug/l total PCBs at BR-G), Site H (9.8 and 12 ug/l at H-S1), and Site I (16000 ug/l, at BR-I) and these data establish release of PCBs to the ground waters beneath these areas. (Tables 3.2 through 3.4).

In addition, PCBs have been detected at some of the EE/CA—RI/FS downgradient ground-water stations hundreds to over a thousand feet from the source areas. Given that PCBs typically do not migrate far, these data have been given additional review. To check the consistency of the data, first I examined the 15 duplicate pair ground-water samples which detected a PCB in at least one member of the pair. Only five (33%) of the 15 pairs detected the same PCB in both members.<sup>51</sup> However, this "inconsistency" appears to be attributable to concentrations being at the brink of detectability, rather than

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<sup>50</sup> In addition to dissolution into infiltrating vadose waters, PCBs are introduced directly into the saturated zone by leaching from NAPL (particularly in the SHU and bedrock where NAPL apparently has concentrated), by leaching from solid or liquid waste poured into a pit either containing ground water or into which ground water later rises, and by leaching from contaminated sub-bed creek sediments through which ground water flows.

<sup>51</sup> The EE/CA—RI/FS chemical analyses differentiated PCBs according to the number of chlorine atoms attached to the biphenyl group. Thus an analytical result is available for the ten groups monochlorobiphenyl, dichlorobiphenyl, ..., and decachlorobiphenyl for each sample. I compared PCBs for each of these groups. (PCB terminology is explained at <http://www.epa.gov/toxteam/pcb/defs.htm>).

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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to sampling or analytical error.<sup>52</sup> Therefore these findings did not justify dismissal of any of the detected values.

Confidence in the detected downgradient PCBs is increased by spatial proximity and similar concentration of contaminated samples. Stations SW-S2 and SW-S3 are 460 ft and 400 ft, respectively, downgradient of CS-B and Site M (Figure 6.1), and both stations exhibited PCBs. The detection of PCBs in four of the ten vertically discrete samples at SW-S2, with heptachlorobiphenyl at 0.05 and 0.08 ug/l in adjacent depth samples (14 ft and 22 ft bgs), and nonachlorobiphenyl at 0.21 and 0.24 ug/l in proximate deep samples (72 and 92 ft bgs), is evidence that PCBs are indeed present in the ground water at this station. Strong corroboration is provided by the detection at SW-S3 of similar concentrations of the same PCB groups at the same depths: heptachlorobiphenyl in the shallowest two samples (0.07J ug/ at 14 ft and 0.06J ug/l at 22 ft bgs) and nonachlorobiphenyl in the bottom sample (0.24 ug/l at 96 ft bgs). Recalling the considerable PCB contamination in sediments of CS-B (e.g., Table 3.9; Roux 2001 Figs. 4-59, 4-62), I conclude that detectable PCBs have migrated over 400 ft from CS-B/Site M notwithstanding the typically low mobility of these substances.

Similarly, detections of PCB at station I-S3, where adjacent depth samples at 104 ft and 110 ft bgs both contained 0.13J ug/l nonachlorobiphenyl (among other PCBs), demonstrate migration more than 1000 ft downgradient from Site I. Detections of PCBs at most other downgradient stations are somewhat spottier vertically. This is reasonable given the low concentrations close to detection limits. The mobility of PCBs in the valley fill aquifer may be enhanced by clean sands which offer little organic substrate for sorption, and by interaction with the relatively elevated dissolved chlorobenzenes; however, at this point these are only speculations.

**PAHs.** The PAH chemicals of interest are acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. Except for acenaphthylene all of these substances were detected, and at their highest values, at Site I bedrock well BR-I. Generally each PAH concentration at BR-I, about 100 to 800 ug/l, exceeded all of its other detections by one to two orders of magnitude. Based on *other* very concentrated compounds in BR-I, the well is believed to be close to residual or pooled DNAPL within or on the surface of the bedrock. It seems likely that the relatively elevated PAHs at BR-I also derive from the NAPL waste.

Other wells within land disposal areas also exhibited PAHs at concentrations mostly less than 10ug/l. Detections occurred at Site G bedrock well BR-G (pyrene, phenanthrene, fluoranthene, chrysene, benzo(k)fluoranthene, anthracene); Site H SHU well EE-01

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<sup>52</sup> The pairs detecting a PCB in both samples included the four most concentrated duplicate samples (from 0.72J to 33J ug/l) plus one low concentration pair (0.11J/0.07J ug/l). The pairs with only one detection were mostly less concentrated, ranging from 0.05J to 0.26J ug/l. Two detection limits are associated with each analysis: the contract required detection limit and the minimum detection limit. The former, ranging from 0.10 to 0.50 ug/l, was always higher than the result, leading to the ubiquitous "J" qualifiers. The latter performance was lower than reported detections and ranged from 0.029 to 0.11 ug/l. Thus it appears that natural variability between duplicates, combined with concentrations near the detection limit, led to the inconsistent detections within duplicates.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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(phenanthrene, fluorene, acenaphthene), depth-profiled well H-S1 (phenanthrene, fluorene) and bedrock well BR-H (fluorene); and Site I south pit SHU well EE-12 (fluoranthene) and northern depth-profiled well I-S4 (indeno(1,2,3-cd)pyrene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(a)anthracene). These results document the release of PAHs to the ground water beneath these source areas.

PAHs have low mobility in ground water, and most downgradient detections are spatially sporadic and at less than 1 ug/l. However, the three Site I downgradient stations detected multiple PAHs, as might be expected given the relatively high source concentrations and likely NAPL at Site I. I infer that several PAHs have migrated from Site I, some over 1000 ft downgradient to I-S3. In particular, phenanthrene (0.47J to 89J ug/l) occurred at four depths in I-S1 immediately west of Site I; and fluorene (5.4J and 0.58J ug/l), chrysene (0.73J and 1.5J ug/l), benzo(k)fluoranthene (0.74J to 1.2J ug/l), benzo(a)pyrene (0.45J to 2J), and benzo(a)anthracene all were detected at both I-S2 and I-S3 (which line up approximately along the N60°W ground-water flow path).

EE-20, a background station located east of northern Site I, detected four PAHs including fluorene (0.24J ug/l at 29 ft bgs), chrysene (1.3J at 60 ft), benzo(a)anthracene (0.97J at 60 ft) and acenaphthene (8J at 100 ft). Although this is indicative of PAHs approaching Site I from upgradient, it does not compromise interpretation of releases from Site I, which were much more concentrated at BG-I.

The possibility exists that low mobility PCBs and PAHs detected substantially downgradient of the source areas initially were released during the 1940s-1980 period of ground-water flow reversal and higher velocities toward Monsanto. If so, they may have originated from locations more to the south than is implied by the current flow direction. For instance, these contaminants detected at I-S3 may have entered the ground water in southern Site I, Site H, or even Site G. The similar PCB profiles at SW-S2 and SW-S3 west of CS-B/Site M and the absence of known sources to the south suggest otherwise: that in 1999 these stations detected a plume oriented to the WNW from the source area. If these issues are important to the litigation, I may perform additional analyses to attempt to resolve them.

### *Site-specific Opinions:*

- (3) Site G has released numerous chemicals of interest to the ground water. Released substances include those indicated by "Y" in the penultimate column of Table 3.2. There also is strong suggestion that those substances indicated by "Y\*" were released.

As discussed in Section 5.2, although Site G is downgradient of Sites H and L the contamination from those sites is expected to affect the aquifer (MHU and DHU) beneath Site G but to have little effect on SHU samples at Site G. In particular, I am confident that Site G SHU well EEG-107, screened in sand beneath Site G waste material and exhibiting substantial concentration maxima for almost all detected Site G chemicals, reflects releases within Site G.

- (4) Site H has released numerous chemicals of interest to the ground water. Released substances include those indicated by "Y" in the penultimate column of Table 3.3.



## **Sauget Area 1 -- Expert Report on Ground Water Contamination**

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There also is strong suggestion that those substances indicated by "Y\*" were released.

The relatively low concentration of Site H contaminants in downgradient SHU well EEG-110 has been attributed to the descent of contaminated ground water below the well (E&E May 1988, pg. 7-34).<sup>53</sup> However, EEG-110 is screened in fine to medium sand; if this material extends to Site H then EEG-110 may indeed intercept flow from Site H. An alternate explanation recognizes that ground water moves approximately N60°W and that EEG-110 is downgradient of the southern tip of Site H where little waste may have been deposited.

- (5) Site I has released numerous chemicals of interest to the ground water. Released substances include those indicated by "Y" in the penultimate column of Table 3.4. There also is strong suggestion that those substances indicated by "Y\*" were released.

Site I has generated the most highly contaminated of the Area 1 ground-water plumes.

- (6) Site L has released numerous chemicals of interest to the ground water. Released substances include those indicated by "Y" in the penultimate column of Table 3.5. There also is strong suggestion that the substance indicated by "Y\*" was released.

- (7) There is no ground-water sampling station in the vicinity of Site N. I have not developed an opinion concerning releases from Site N, but may do so as additional information is developed.

The presence of several chemicals of concern in soil samples from Site N (Section 3.1.6) implies that releases occurred; inferences on migration to ground water await further sampling from the Site.

### **6.2.2 Contaminated Surface Water**

Industrial wastes have been discharged to surface water within Area 1 in Dead Creek segments CS-A and CS-B. Site M also has received contaminated CS-B waters through its hydraulic connection to the creek. For each of these sites surface water, sediment, and ground-water data are available. Differences in Site history and potential interference from land disposal Site releases prompted a different interpretive approach for each Site.

*General Bases of Opinions:* My conclusions concerning releases from surface water bodies to the ground water within Area 1 are based on the following:

Information on historical usage of Dead Creek for liquid disposal, including direct discharge from industrial pipes, runoff, and truck wash water, and industrial surge pond flow, as described or cited in Sections 3.2 and 3.3;

Physical evidence of wastes within the creek and Site M, including from interpreted aerial photographs and from observations of waste, discoloration, fires and smoldering by site regulators and investigators, as described in Sections 3.2 and 3.3;

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<sup>53</sup> The boring is shallow (20 ft logged), and no log of deeper materials is available at that location.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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Analytical results for chemical of interest within the water body sediments, as described or cited in Section 3.2;

Analytical results for chemicals of interest in surface water as described or cited in Section 3.2.1, and in ground water as described in Sections 5.3.7 and 5.3.8;

Migration of ground water and contaminants by recognized mechanisms as described in Sections 4.3, 5.1 and the hydrogeologic literature.

### **Site-Specific Opinions**

- (8) Dead Creek segment CS-A has released hazardous substances into the underlying ground water. Released substances including at least those indicated by "Y" in the penultimate column of Table 3.8.

I rely principally on sediment quality data to identify the chemicals of interest released from surface waters to the ground water. I use sediment data because of potential interference in ground-water samples by upgradient land disposal Sites. In particular, ground water beneath and downgradient of CS-A also is downgradient of Site I. Therefore it is problematic to identify a ground-water sampling station which unambiguously characterizes releases from CS-A.

Even so, well EE-15 is known to reflect a water level rise which is attributed to leakage from CS-A. This suggests that the well also intercepts ground-water flow from CS-A to some degree. Therefore I have referred to the two EE-15 samples in forming my opinions (Table 3.8). Only two chemicals of interest were not in CS-A sediment samples yet were detected in EE-15 samples: vinyl chloride and 2-chlorophenol. The former is a degradation product of 1,2-dichloroethene which is present in sediment samples.

I have concluded that a substance was released to the ground water from CS-A if that substance is present in the sediments beneath CS-A according to at least one of the available chemical analyses.<sup>54</sup> My conclusions on release from CS-A to ground water rely on the knowledge that the identified chemicals of interest are mobile in ground water, that their sorption between Site sediments/soils and water is reversible, and that surface water infiltrates the creek or pond bottom and enters the ground water (CS-A was a losing stream). The presence of these chemicals in multiple ground water samples within Area 1 illustrates the first two points. The observed ground-water mound in CS-A (Section 4.3.2) demonstrates the last point, which is as expected due to the creek bed being elevated above the water table.

The tally of chemicals adsorbed to creek sediments is unlikely to reflect the full array or magnitude of substances formerly within the surface waters or released through the creek bottom to the ground water. Waste concentrations likely declined within CS-A as industries reduced or ceased their discharges to the sewers, and as the sewers were upgraded. The waste constituents in stream sediments decades after releases tend to be those which were substantially retarded by sorption and resist volatilization and chemical/biochemical degradation. Conversely if a hydrophilic (low sorption), volatile, degradable compound is found, it seems likely that it was formerly present in the surface

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<sup>54</sup> However, I do not rely on the IEPA 1980 and 1981 analyses.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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water in relatively large quantity. Several of the VOCs of interest are particularly subject to this comment.<sup>55</sup>

Therefore the substances detected in the water body sediments likely comprise a subset of those released to the ground water beneath the water bodies, and the relative concentrations within the sediments likely do not reflect those formerly in the surface waters or those induced in the receiving ground waters.

Inference of additional released substances based on industrial disposal records (e.g., records of wastes discharged to the sewers) seems reasonable but is outside the scope of this report.

- (9) Dead Creek segment CS-B has released hazardous substances into the underlying ground water. Released substances include at least those detected in creek sediments above background as indicated by "Y" in Table 3.9.

I have concluded that a substance was released to the ground water from CS-B or Site M if that substance is present in the sediments beneath the water body according to at least one of the available chemical analyses.<sup>56</sup> I do not rely principally on ground-water quality data; nevertheless that data does provide some support for my conclusions. Because of an expected decline of source and ground-water concentrations in the decades since waste disposal to CS-B ceased in 1968, and interference by releases from adjacent land disposal Sites, ground-water quality data plays a subordinate role in delineating releases from CS-B and Site M.

The timing and concentration of releases from the creek were controlled by variations in the volume and water quality of the sewer surge pond effluent, direct industrial effluent (Midwest Rubber, perhaps others) and directly discharged truck wash water. All of these activities declined and then ceased years prior to any ground-water sampling events downgradient of CS-B. (The CS-B surge pond function ended in 1968; the earliest ground water samples were in 1987). Available ground-water sampling stations are within one to two years ground-water travel time from CS-B (Sect. 4.3.2). As a consequence, the absence of a contaminant in recently sampled ground water, although potentially good news for remedial purposes, is inconclusive concerning releases during the decades that CS-B received industrial wastes.

As with CS-A, my inferences on release from CS-B and Site M to ground water using sediment data rely on the knowledge that the identified chemicals of interest are mobile in ground water, that their sorption between site sediments/soils and water is reversible, and that surface water infiltrates the creek or pond bottom and enters the ground water.

As with CS-A and for the same reasons, the substances detected in the sediments likely comprise a subset of those released to the ground water beneath the water bodies, and

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<sup>55</sup> As noted in a footnote to Section 3.2.1, the E&E (May 1988) analyses of sediment VOCs were subject to false negatives due to use of an insensitive analytical method. Of the VOCs of interest, only tetrachloroethene was detected by other sampling events and not by E&E (Tables 3.8, 3.9). Therefore for the purposes of this report that analytical method limitation appears to be of limited significance.

<sup>56</sup> However, I do not rely on the IEPA 1980 and 1981 analyses.

## **Sauget Area 1 – Expert Report on Ground Water Contamination**

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the relative concentrations within the sediments likely do not reflect those formerly in the surface waters or those formerly induced in the receiving ground waters.

Inference of additional released substances based on industrial disposal records (e.g., records of wastes discharged to the sewers, in truck wash waters, etc.) seems reasonable but is outside the scope of this report.

Current ground-water samples can reveal contaminants which continue to desorb from CS-B sediments, although concentrations may be much lower than in the past. The ground-water sampling stations downgradient of CS-B least likely to be affected by the "lettered" land disposal sites are EEG-103, EEG-104 and SW-S1. If one assumes that Site M is simply an embayment of CS-B with no wastes other than those derived from CS-B, then the downgradient stations EEG-105, SW-S2, and SW-S3 also are included in this list.<sup>57</sup> These three or six stations then should reflect current ground-water quality downgradient of the middle and lower thirds of CS-B with relatively little likelihood of interference from known land disposal sites.

EE/CA—RI/FS water quality data for these stations and a background well are tabulated in Table 3.9. Several of the contaminants detected in CS-B sediments also have been detected at these downgradient stations, including chlorobenzene, toluene, xylenes, 4-chloroaniline, 2-chlorophenol, 1,2-dichlorobenzene, 1,4-dichlorobenzene, phenanthrene, and 2,4,6-trichlorophenol.<sup>58, 59</sup> However, a number of substances in the sediments were not found in these six wells. As explained above, it is my opinion that those substances nevertheless were released to the ground water. Moreover, these sampling stations do not reflect any releases from the upstream third of CS-B where wastes first entered the creek segment.

- (10) Site M has released hazardous substances into the underlying ground water. Released substances include at least those detected in pond sediments above background as indicated by "Y" in Table 3.6.

Pond M is essentially an embayment of CS-B, and the comments made with respect to CS-B generally apply here as well. The contaminants in Site M sediments are a subset of those in CS-B sediments; only trichloroethene was detected in Site M and not in CS-B. The presence of PCBs and PAHs in ground water station SGW-S1/TS-S1, although on the upgradient edge of the pond, likely reflects past releases from Site M of these persistent, relatively low mobility substances.

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<sup>57</sup> These stations are arguably outside of the Site M shadow, but small shifts in inferred flow direction would change that conclusion.

<sup>58</sup> Benzene is omitted from this list because it was also detected at similar concentration in the background station EEG-108.

<sup>59</sup> E&E also sampled SHU wells EEG-103 and EEG-104 (but apparently not EEG-105) and detected the following chemicals of interest (in ug/l): chloroform (3J, 9), benzene (1J), toluene (3J), chlorobenzene (5, 5), naphthalene (8J), PCB Aroclor 1260 (14J) and mercury (2.1) (E&E May 1988 App. D).

### **6.2.3 Leaking Sewers**

#### ***General Bases of Opinions***

My opinions on releases from the industrial sewers to ground water within Area 1 are based on the following:

My understanding of Mr. Klingenstein's opinions concerning historical discharge of sewage to private and Village sewers within Area 1;

My understanding of Mr. Klingenstein's opinions concerning historical leakiness of Area 1 private and Village sewers;

Downward migration of leaking fluids and contaminants to the ground-water table by recognized mechanisms as described in Sections 4.3, 5.1 and the hydrogeologic literature.

#### ***Site Specific Opinions***

(11) For an unknown but likely several decade period leaking Village sewer pipes discharged waste water to the surrounding soil within Area 1, and infiltration carried contaminants to the ground water. Other US expert witnesses address the specific chemicals of concern in the sewer waters.

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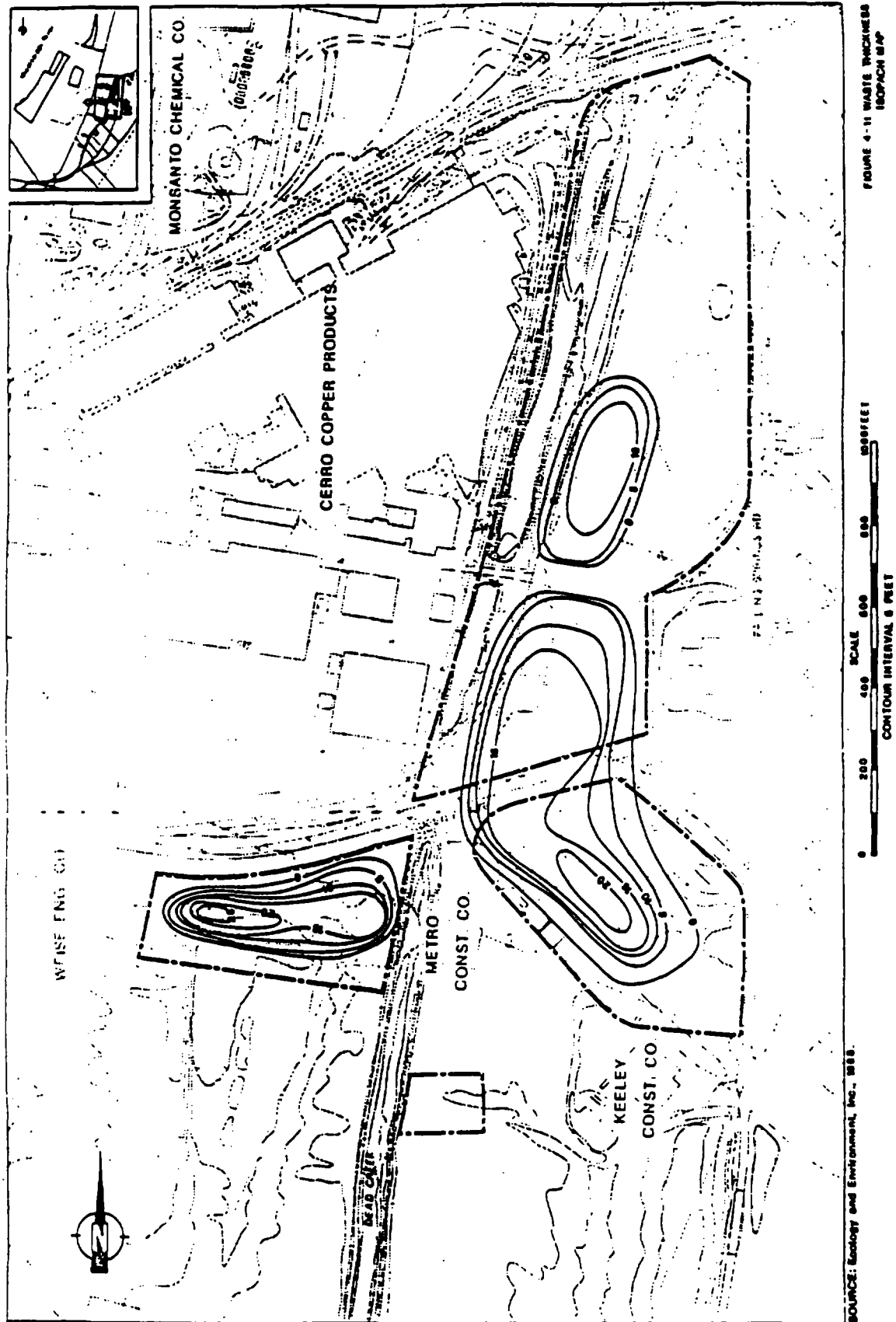
## FIGURES



Figure 2.1 Site Map  
 Chirlin & Associates, Inc.  
 October 7, 2002

June 1997 Aerial Photo





SOURCE: Ecology and Environment, Inc., 1988.

FIGURE 4-11 WASTE THICKNESS ISOPACH MAP

Figure 3.1 Waste Thickness Isopach Map

37350

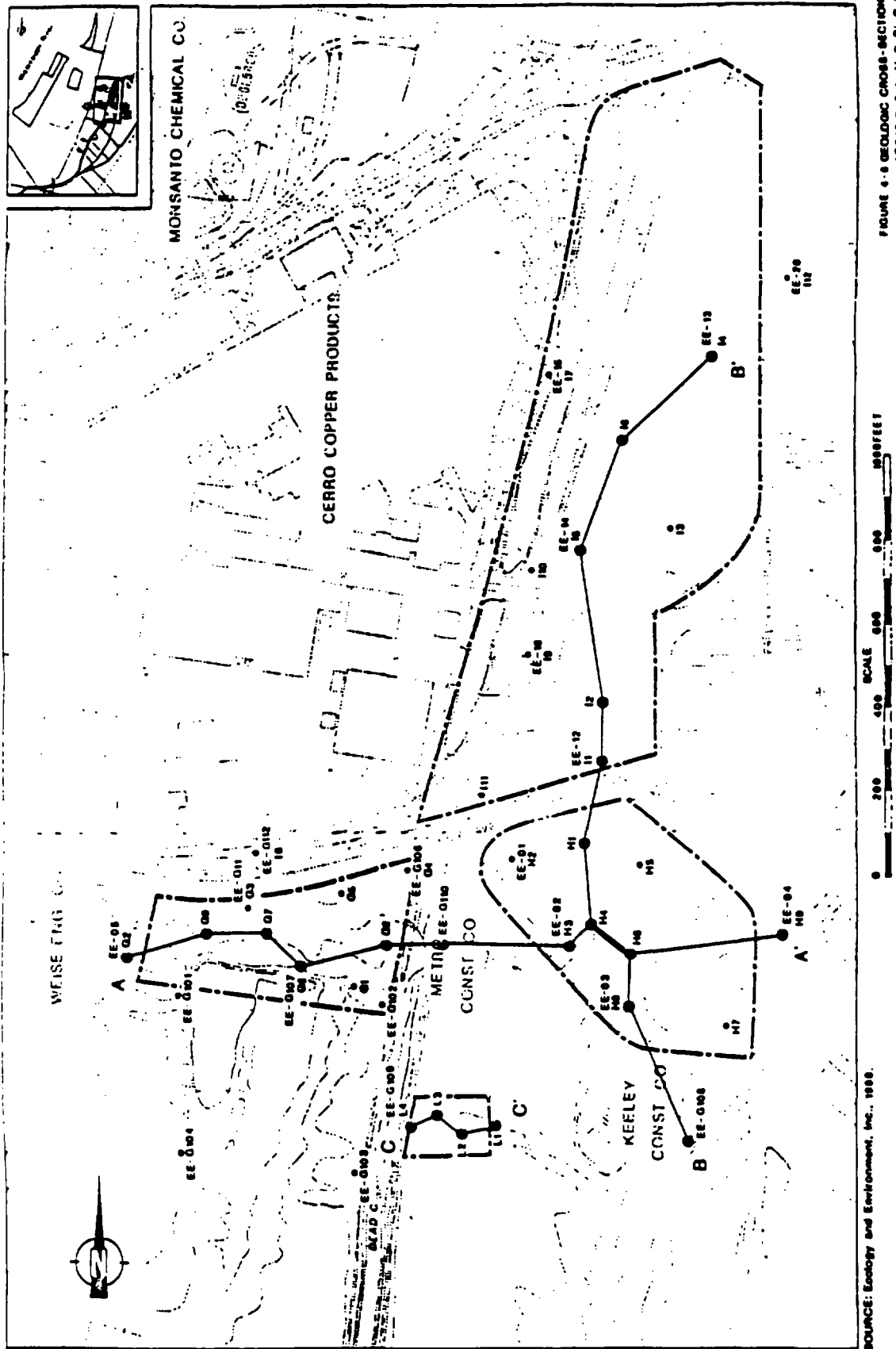


Figure 3.2 Geologic Cross-section  
Locations

FIGURE 4-8 GEOLGIC CROSS-SECTION  
LOCATIONS A-A', B-B', C-C'

SOURCE: Ecology and Environment, Inc., 1988.

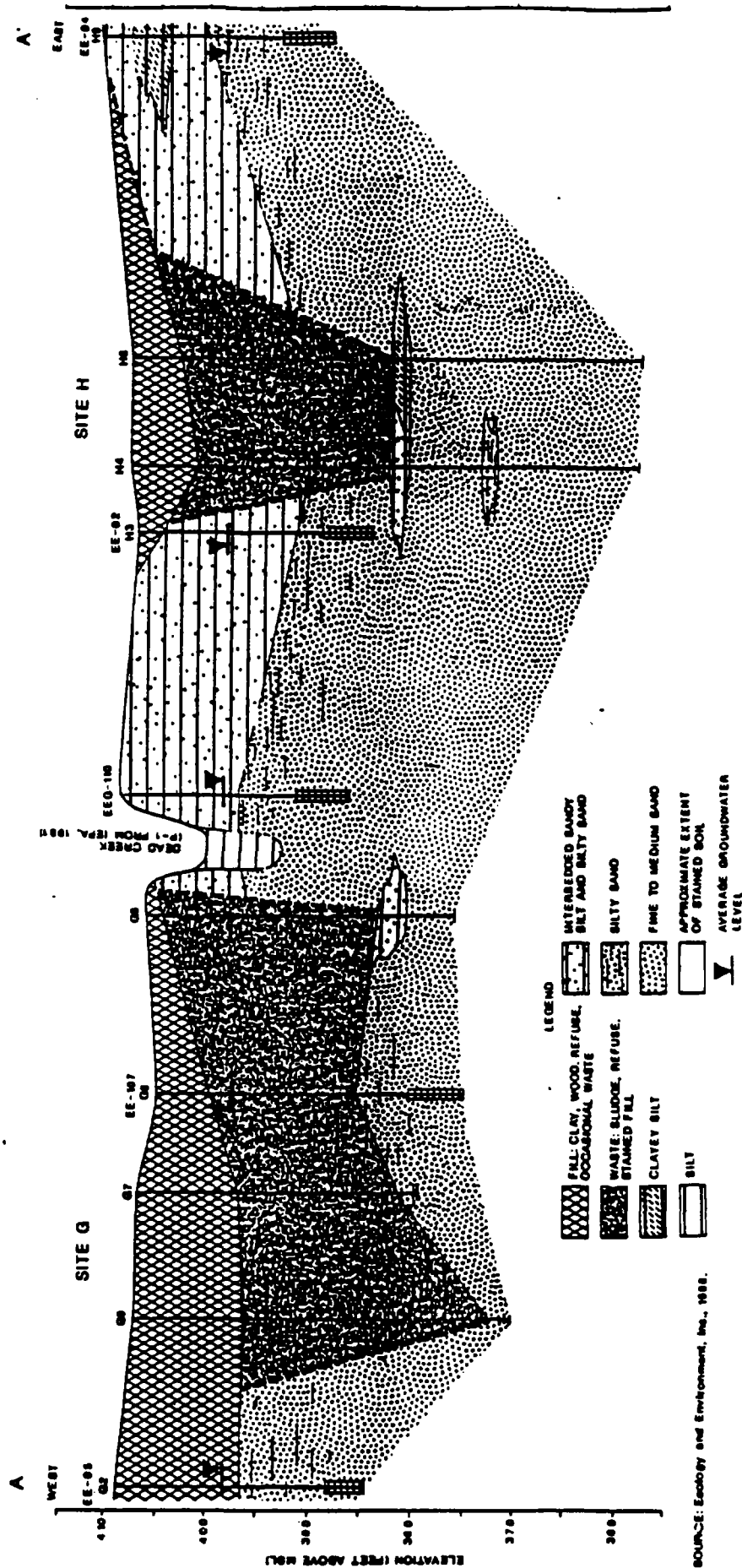


Figure 3.3 Generalized Geologic Cross-section A-A' (Sites G, H)

37349



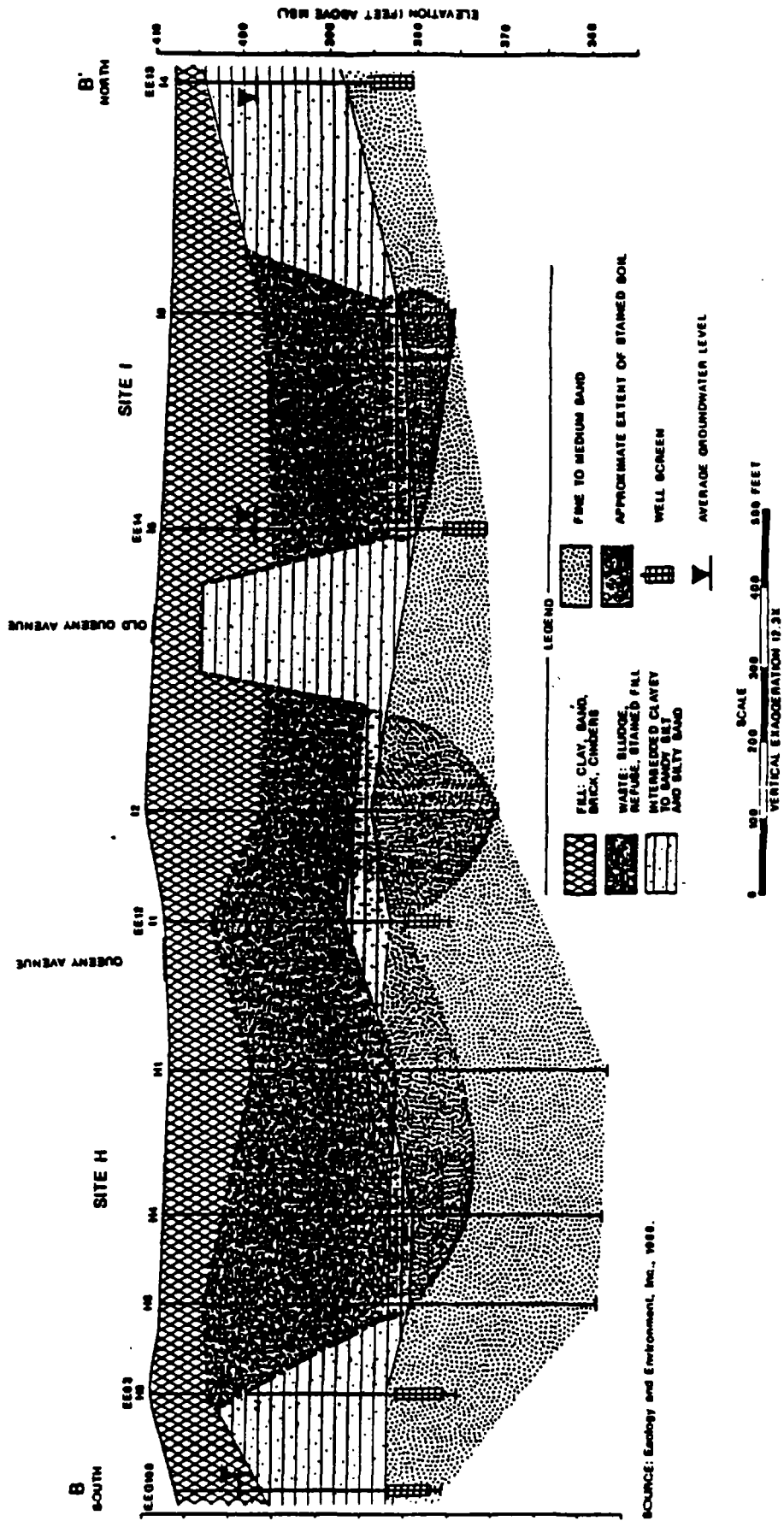
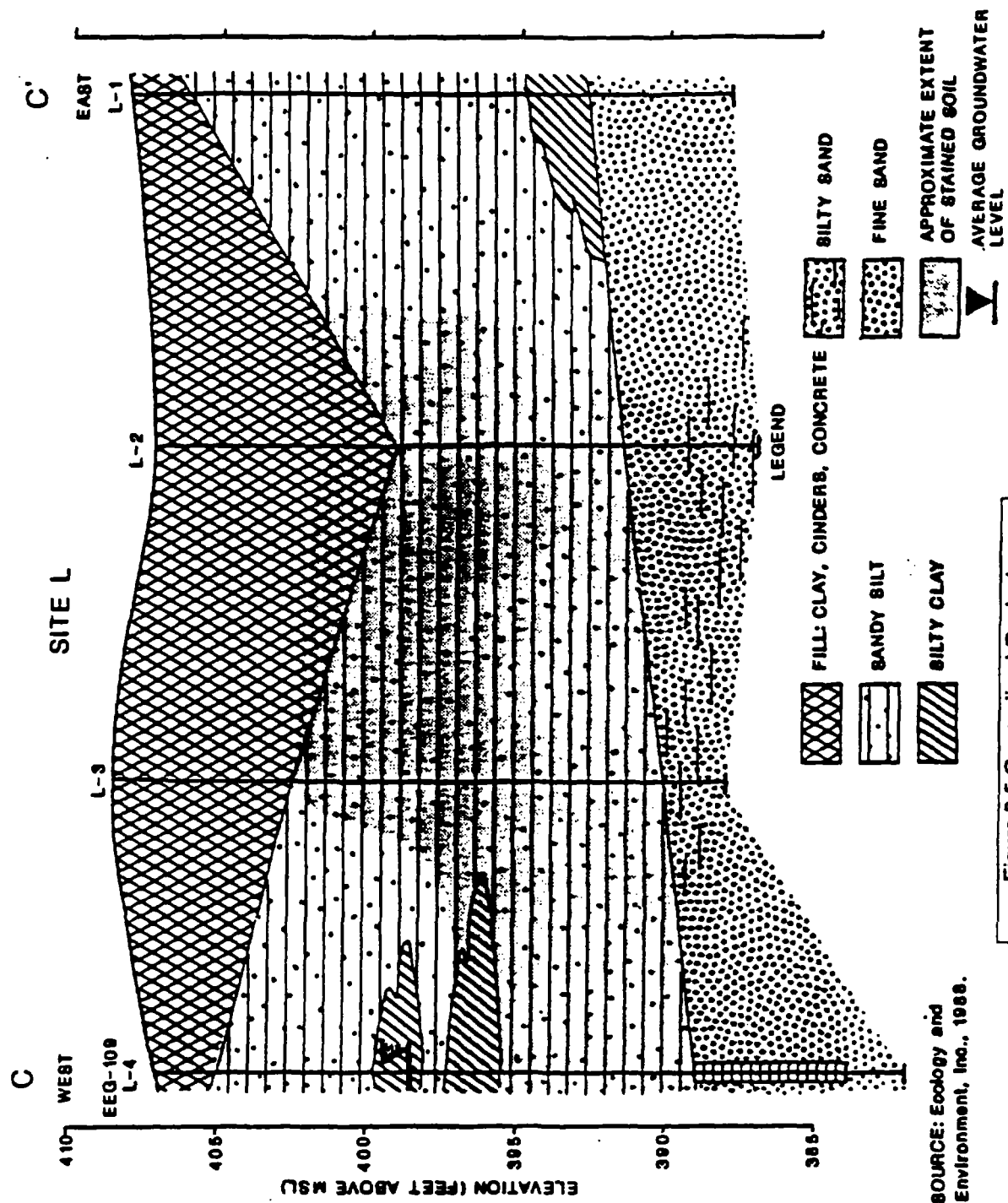
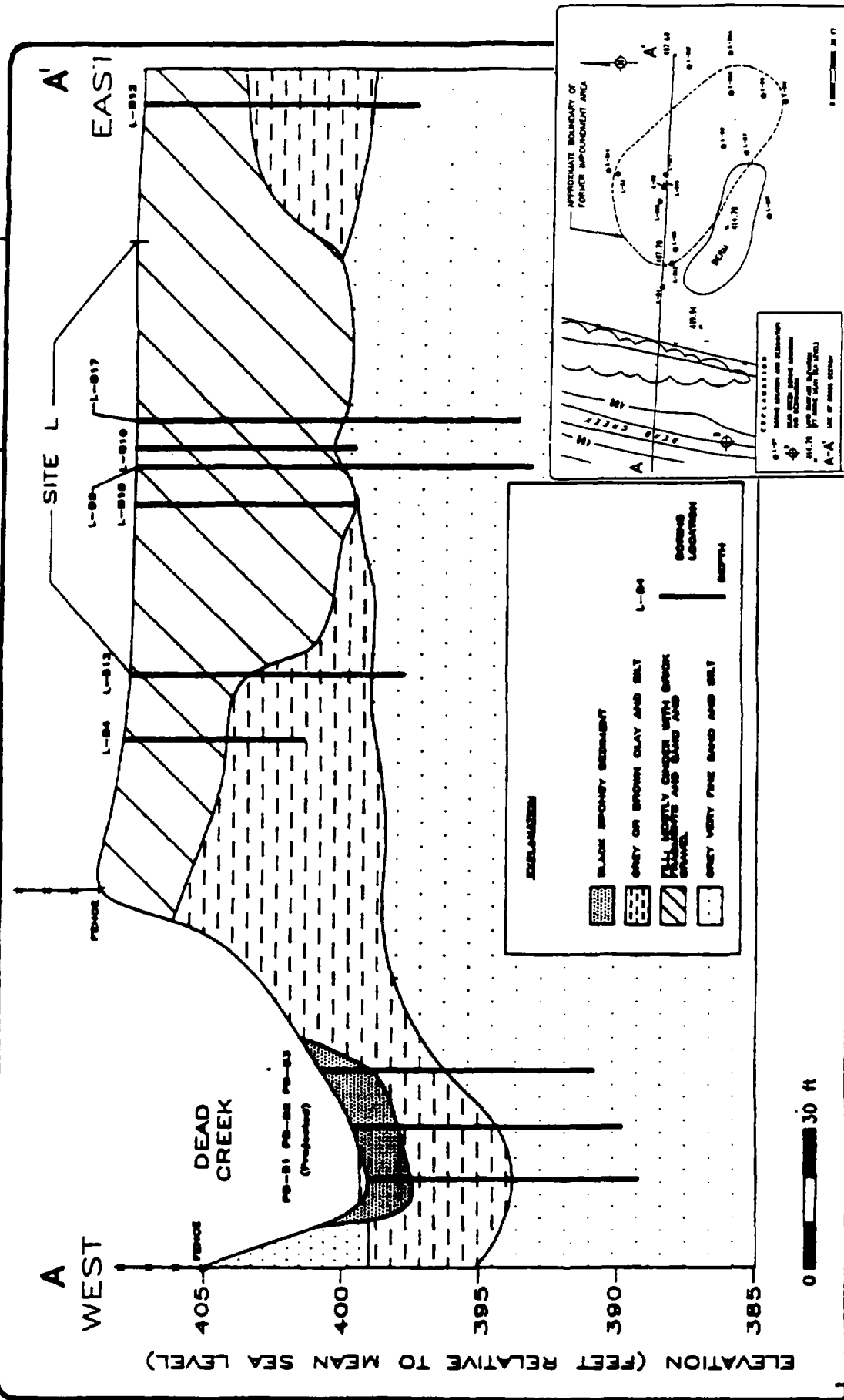


Figure 3.4 Generalized Geologic Cross-section B-B' (Sites H, I)



SOURCE: Ecology and Environment, Inc., 1988.

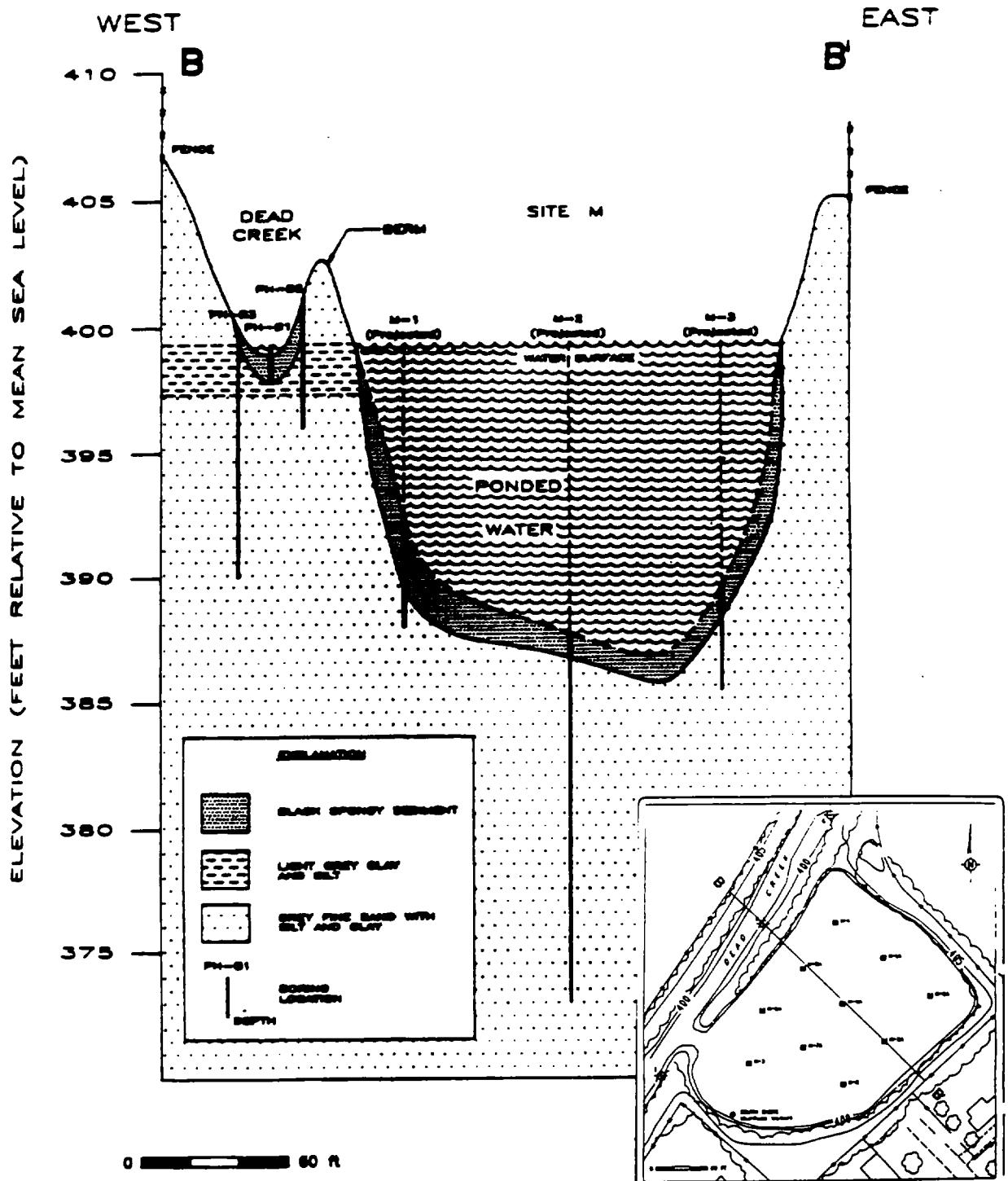
Figure 3.5 Generalized Geologic Cross-section C-C' (Site L)



FIGURE

Figure 3.6 Generalized Cross-section A-A'  
Dead Creek Sector B and Site L

DWG DATE: 02/04/92 | PRJCT NO.: NY80508 | FILE NO.: 1444 | DRAWING: XSEC-B-B' | CHECKED: S.A. BLUM | APPROVED: S.A. BLUM | DRAFTER: H. FRIEDMAN



**GERAGHTY & MILLER, INC.**  
 Environmental Services

Figure 3.7 Generalized Cross-section B-B'  
 Dead Creek Sector B and Site M

FIGURE

MONSANTO COMPANY ST. LOUIS, MISSOURI

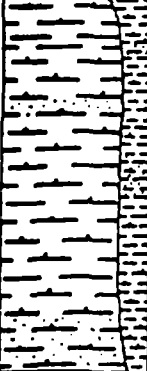
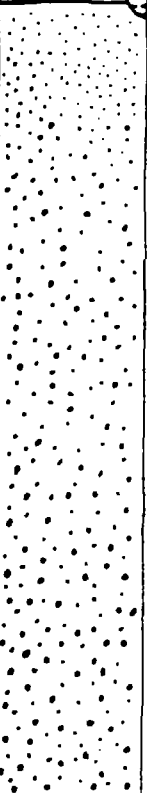
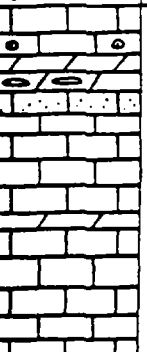
System	Series	Stage	Formation	Column	Thickness (in ft)	Description
Quaternary	Pleistocene	Holocene	Cahokia Alluvium		6-20	Silt, light tan, w/clay and fine sand locally, micaceous.
		Wisconsinan	Henry		100-114	Sand, tan, arkosic, fine grained at top coarsening downward to include some fine to medium grained gravel. Subrounded, moderately sorted.  Contains: Quartz, chert, feldspars, limestone, ferromagnesian minerals, shell fragments; wood chips and coal fragments at top.
		Group				
Mississippian	Valmeyeran	Middle Valmeyeran			100+	Limestone

Figure 4.1

Generalized Geologic Column for unconsolidated deposits to bedrock in the Dead Creek area.

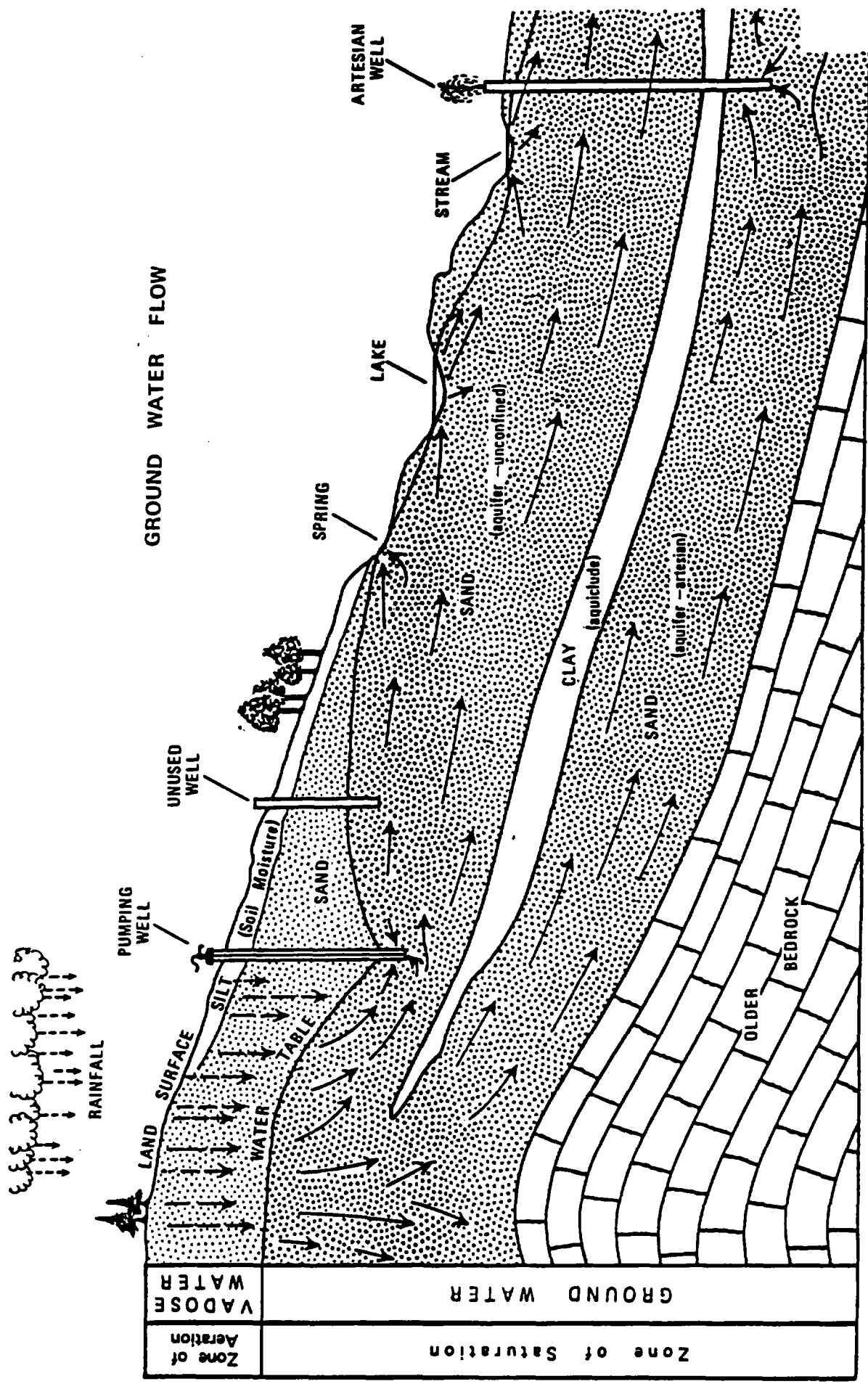
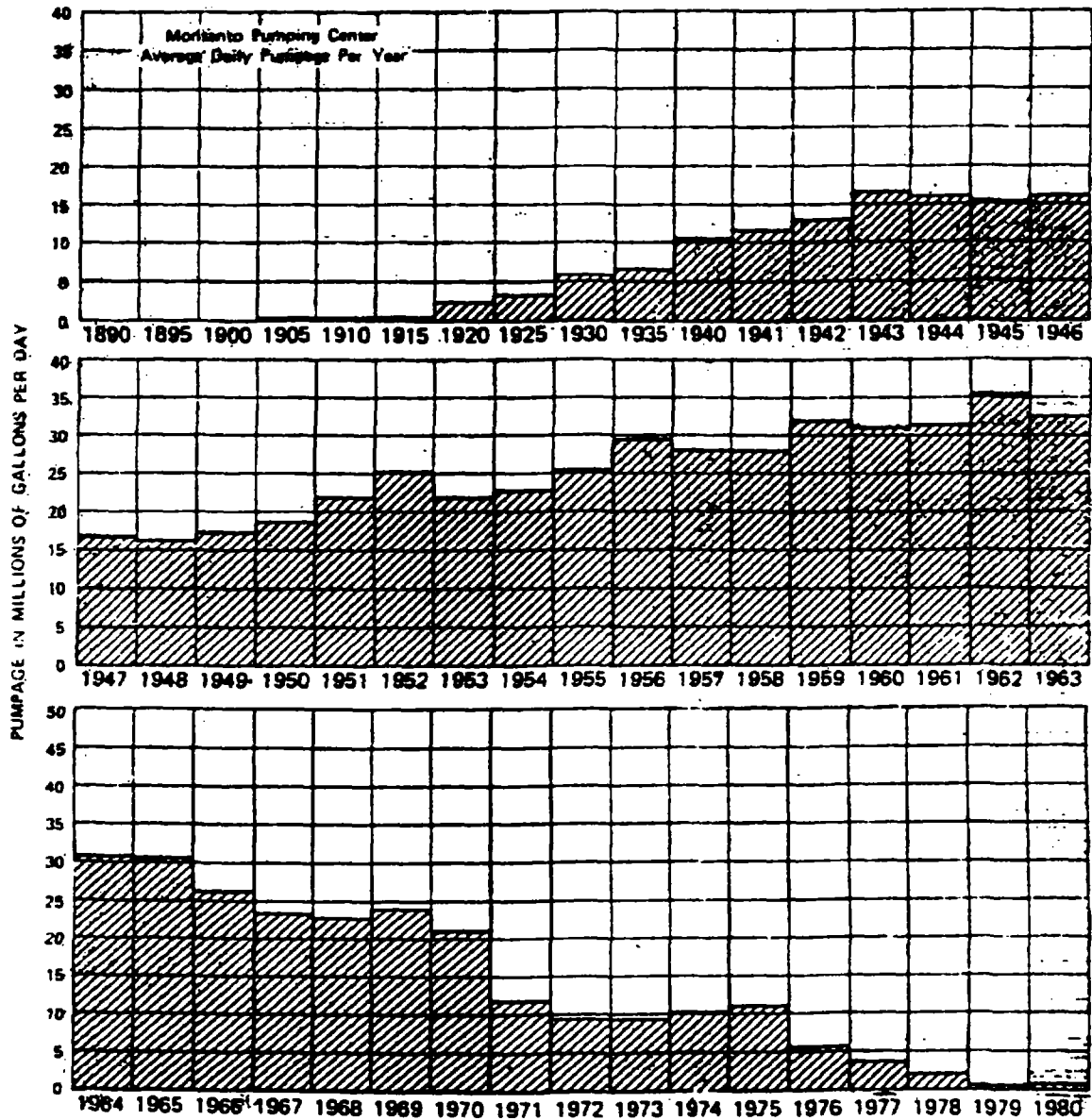
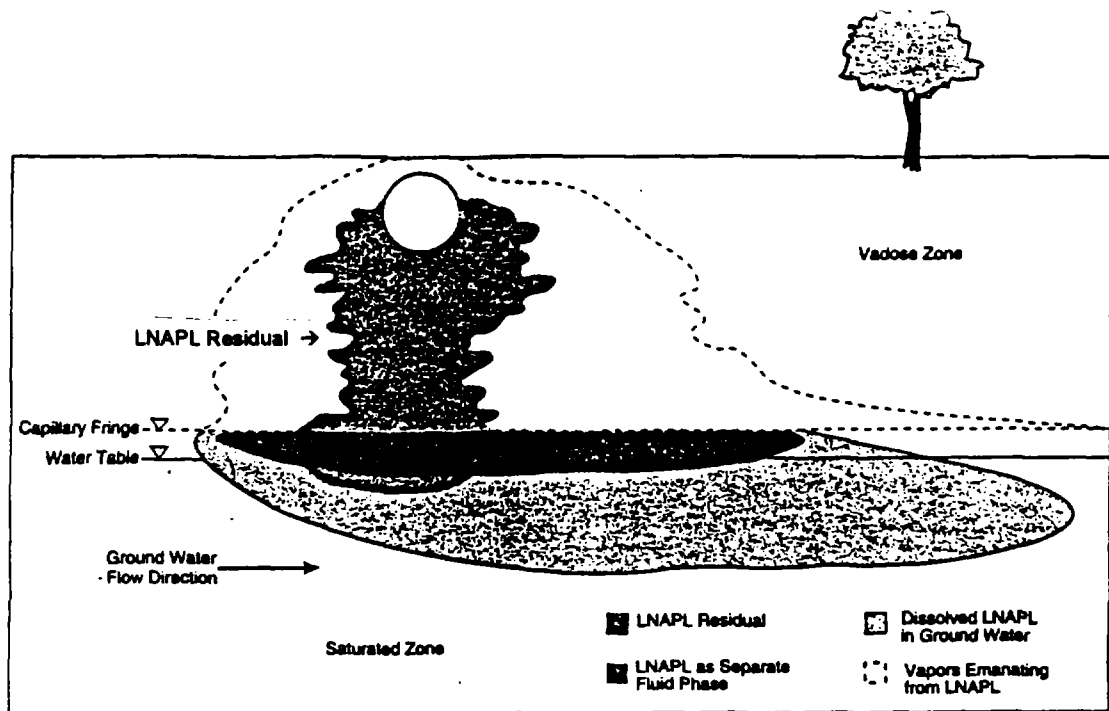


Figure 4.2 Hypothetical Ground Water System



ESTIMATED PUMPAGE IN THE EAST ST. LOUIS-SAUGET-CAHOKIA AREA, 1890-1980  
MONSANTO COMPANY, SAUGET, ILLINOIS



Conceptual diagram of LNAPL transport through the subsurface. As the diagram indicates, some LNAPL remains entrapped in the soil pores, some remains as a separate fluid phase near the spill source and on top of the water table, some vaporizes into the soil pores, and some dissolves in the ground water to form a plume. SOURCE: Modified from API, 1989.

Figure 5.1 LNAPL in the Subsurface

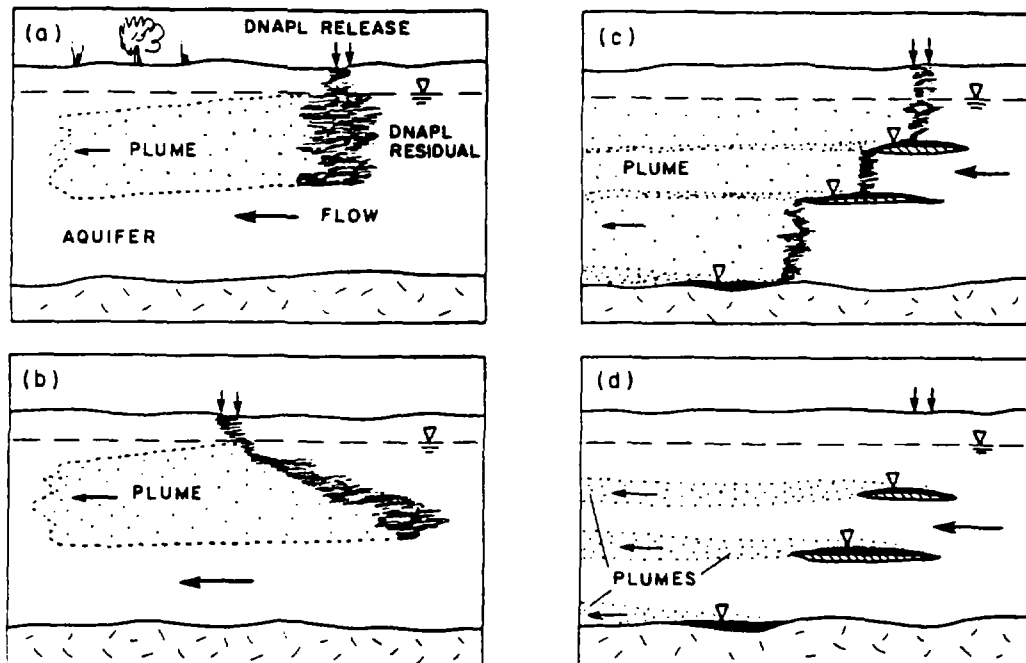


Figure 2.5 Conceptual scenarios for a DNAPL in the groundwater zone in granular aquifers: a) partial penetration; b) partial penetration with offset; c) full penetration with offset; and d) same as part c, but at a later stage after DNAPL residual has disappeared due to dissolution in flowing groundwater.

Figure 5.2 DNAPL in the Subsurface







**Figure 6.2 Chlorobenzene Distribution  
in Area 4 Ground Water--  
Used to Illustrate Uncertainty**

**Chirlin & Associates, Inc.**  
**August 6, 2002**

EEG-102 is misplaced throughout

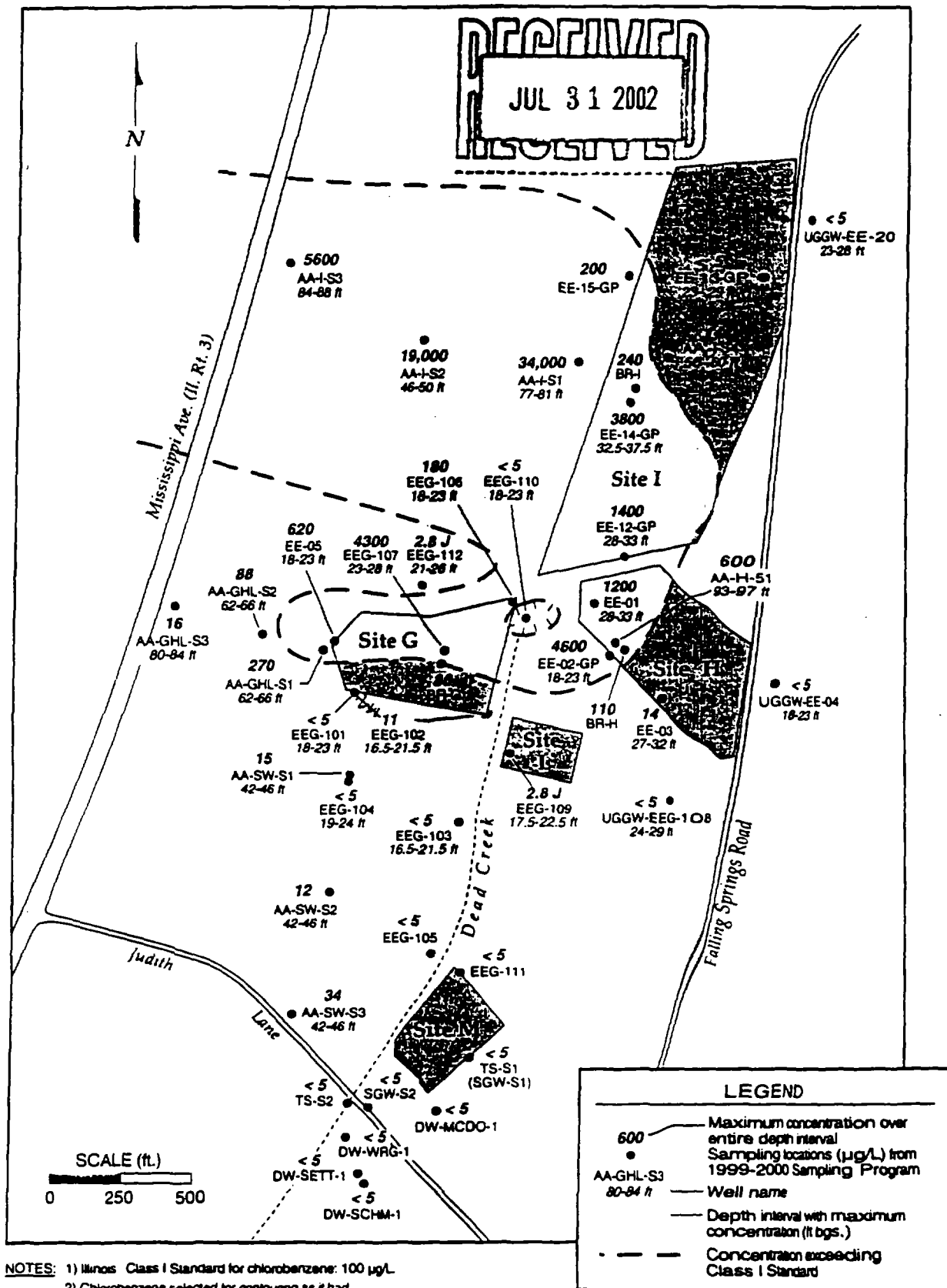


Figure 6.3



GSI Job No.	G-2484	Drawn By:	DLB
Issued:	5/31/01	Chkd By:	CJN
Revised:		Apprd By:	CJN
Scale:	As Shown		

## CHLOROBENZENE CONCENTRATIONS IN GROUNDWATER

Solutia, Inc.  
Sauget Area 1, Sauget and Cahokia, Illinois

## TABLES

**Table 3.1 Chemicals of Interest**

**VOCs**

Benzene
Chlorobenzene
Chloroform
Cis or Trans 1,2-dichloroethene
Ethylbenzene
4-methyl-2-pentanone
Tetrachloroethene
Toluene
Trichloroethene
Vinyl chloride
Xylenes, total

**SVOCs**

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Carbazole
4-Chloroaniline
2-Chlorophenol
Chrysene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4-Dichlorophenol
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene
2-Methylphenol
3- or 4-Methylphenol
Naphthalene
2-Nitroaniline
4-Nitroaniline
Nitrobenzene
Phenanthrene
Phenol
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

**Table 3.1 (cont.) Chemicals of Interest**

***Herbicides, Pesticides***

	2,4-D
	4,4'-DDT
	4,4'-DDE
	MCPP[2-(4-chloro-2-methylphenoxy)-propionate]
	Pentachlorophenol
	2,4,5-T

***PCBs***

Aroclor 1248  
Aroclor 1254  
Aroclor 1260  
Total PCBs

***Metals***

Chromium  
Lead  
Mercury  
Molybdenum  
Nickel  
Selenium  
Vanadium  
Zinc

**NOTE:**

Pentachlorophenol also is analyzed as an SVOC.

Table 3.2 Site G Chemical Maxima

Chemical	WASTE AND SOIL				GROUND WATER				BACKGROUND	RELEASED FROM WTE To DW?	Chemical
	WASTE & SOIL EPA (1980 & 1984) (mg/kg) Station 12	SURFACE SOIL E&E (1986) (mg/kg) Station 43	SURFACE SOIL E&E (1987) (mg/kg) Station 12	SURFACE SOIL G&M (1991) (mg/kg) Station 1 organics 3 metals	TCLP LEACHATE ORG (1999) (ug/l) Station 4	BRU (ug/l) Station	M&J ORG (2000) (ug/l) Station	DHJ (ug/l) Station			
VOCs											VOCs
Benzene	0.58	0.08	45	nd	920	37000	EEG-107	GHL-S2	nd(5)	Y	Benzene
Chlorobenzene	WS-2	0.04	540E	2J	2700	43000	EEG-107	GHL-S1	11	Y	Chlorobenzene
Chloroform		nd	12	nd	nd(20)	190	EEG-107	nd(5)	nd(5)	N	Chloroform
Cis or Trans 1,2-dichloroethene		nd	0.7J	nd	x	nd(5)	EEG-107	GHL-S2	nd(5)	Degr	Cis or Trans 1,2-dichloroethene
Ethylbenzene		0.14	SS-38	17	x	32	EEG-107	GHL-S2	nd(5)	Y	Ethylbenzene
4-methyl-2-pentanone		2	SS-33	6	x	1300	EEG-107	nd(25)	5.9	Y	4-methyl-2-pentanone
Tetrachloroethene		0.063	SS-11	59	130	170	EEG-107	GHL-S2	nd(5)	Y	Tetrachloroethene
Toluene		1.4	SS-38	120	B-B1	85000	EEG-107	1J	nd(5)	Y	Toluene
Trichloroethene		0.019	SS-38	3.8	79	200	EEG-107	GHL-S2	nd(2.7)	Y	Trichloroethene
Vinyl chloride		nd	nd	nd	nd(40)	41J	EEG-107	nd(10)	nd(10)	Degr	Vinyl chloride
Xylenes, total		0.17	SS-38	42	x	130	EEG-107	nd(5)	nd(5)	Y	Xylenes, total
SVOCs											SVOCs
Acenaphthene		1.8J	SS-16	2.7J	x	nd(10)		nd(10)	nd(10)	N	Acenaphthene
Acenaphthylene		nd	nd	nd	x	nd(10)		nd(10)	nd(10)	N	Acenaphthylene
Anthracene		4.1	SS-43	8.5J	x	nd(10)		0.36J	nd(10)	N	Anthracene
Benzo(a)anthracene		2.7J	SS-16	nd	x	nd(10)		1.9J	nd(10)	B	Benzo(a)anthracene
Benzo(b)fluoranthene		4	SS-18	nd	x	nd(10)		3.7J	nd(10)	Y	Benzo(b)fluoranthene
Benzo(k)fluoranthene		10	SS-25	nd	x	nd(10)		5.9J	nd(10)	Y	Benzo(k)fluoranthene
Benzo(a)pyrene		22J	SS-15	nd	x	nd(10)		5.7J	nd(10)	Y	Benzo(a)pyrene
Carbazole		x	x	x	x	nd(10)		nd(3.4)	nd(10)	?	Carbazole
4-Chloroaniline		nd	230J	G7-69	x	23000D	EEG-107	GHL-S2	nd(20)	Y	4-Chloroaniline
2-Chlorophenol		nd	8.8	G5-37	x	630	EEG-107	GHL-S1	nd(10)	Y	2-Chlorophenol
Chrysene		39J	SS-15	23	1.7	nd(10)		0.53J	nd(10)	Y	Chrysene
1,2-Dichlorobenzene		0.089J	SS-23	nd	nd(0.49)	nd(10)		2.4J	nd(10)	B	1,2-Dichlorobenzene
1,3-Dichlorobenzene		nd	nd	nd	x	1.9J	EE-05	GHL-S1	nd(10)	Y	1,3-Dichlorobenzene
1,4-Dichlorobenzene		22000	SS-21	3.8J	320	850	EEG-107	GHL-S1	nd(10)	Y	1,4-Dichlorobenzene
2,4-Dichlorophenol		6.2	SS-40	140J	x	3600	EEG-107	nd(10)	nd(10)	Y	2,4-Dichlorophenol
Fluoranthene		45	SS-16	6.6J	x	nd(10)		0.52J	nd(10)	Y	Fluoranthene
Fluorene		1.5J	SS-43	11	x	nd(10)		nd(1)	nd(1)	N	Fluorene
Indeno(1,2,3-cd)pyrene		5.2	SS-43	nd	x	nd(10)		5.6J	nd(10)	Y	Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene		1J	SS-11	37J	x	230J	EEG-107	nd(10)	nd(10)	Y	2-Methylnaphthalene
2-Methylphenol		nd	nd	3.6J	99	2400	EEG-107	nd(10)	nd(10)	Y	2-Methylphenol
3- or 4-Methylphenol		nd	4-MP only	x	150	nd(10)		nd(10)	nd(10)	Y	3- or 4-Methylphenol
Naphthalene		120	SS-17	5400	x	2100	EEG-107	nd(10)	nd(10)	Y	Naphthalene
2-Nitroaniline		220	SS-37	nd	x	nd(50)		nd(50)	nd(50)	?	2-Nitroaniline
4-Nitroaniline		nd	nd	nd	x	8.4J	EE-05	nd(50)	nd(50)	?	4-Nitroaniline
Nitrobenzene		nd	nd	nd	x	nd(3.5)		nd(3.5)	nd(3.5)	N	Nitrobenzene
Phenanthrene		40J	SS-15	51J	x	nd(10)		0.89J	nd(10)	Y	Phenanthrene
Phenol		0.078J	SS-23	178	x	14000D	EEG-107	nd(10)	nd(10)	Y	Phenol
Pyrene		85	SS-15	19	x	nd(10)		nd(10)	nd(10)	Y	Pyrene
1,2,4-Trichlorobenzene		35	SS-34	120J	x	180J	EEG-107	nd(10)	nd(10)	Y	1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol		nd	nd	nd	nd(50)	nd(10)		nd(10)	nd(10)	?	2,4,5-Trichlorophenol
2,4,6-Trichlorophenol		1.5J	SS-40	50J	7100	0.47J	EEG-106	nd(2.1)	nd(2.1)	Y	2,4,6-Trichlorophenol

Table 3.2 Site G Chemical Maxima

Chemical	Number of Samples	WASTE AND SOIL			GROUND WATER			BACKGROUND	RELEASED FROM SITE To GW?	Chemical
		WASTE & SOIL IEPA (1980 & 1984) (mg/kg) Station	SURFACE SOIL E&E (1986) (mg/kg) Station	SURFACE SOIL E&E (1987) (mg/kg) Station	SURFACE SOIL G&M (1991) (mg/kg) Station	TCLP LEACHATE ORG (1993) (ug/l) Station	SHU (ug/l) Station	ORG (2000) (ug/l) Station	DRU (ug/l) Station	BEDROCK (ug/l) Station
Herbicides, Pesticides	2,4-D 4,4'-DDT 4,4'-DDE MCPPI2 (4-chloro-2-methylphenox)-propenates	x nd 0.29 x 21000 x	nd SS-07 SS-39 SS-39 x	x nd 140J x 4800 x	x x x x 2.9 x	60000 x x x 1100 x	120 nd(0.1) 4J nd(120) 2000 24J	nd(0.5) nd(0.1) nd(0.1) nd(120) 0.13J nd(0.5)	nd(0.5) nd(0.1) nd(0.1) nd(120) 68J nd(0.5)	440D 18J nd(20) 2500J 76J 18J
PCBs	Aroclor 1248 Aroclor 1254 Aroclor 1260 Total PCBs	24000 29000 21000 18 WS-3	SS-11 SS-11 SS-11 SS-11	170C nd 4400 70	B-B1 nd nd S-41#	250J nd nd 28.6 mg/kg (not TCLP)	0.18 GHL-S1	0.26 GHL-S2	0.14 GHL-S1	73 BR-G
Metals	Chromium Lead Mercury Molybdenum Nickel Selenium Vanadium Zinc	30 WS-3 340 WS-3 26 WS-3 43 G106-15 10000 WS-3	SS-15 SS-40 SS-27 SS-12 SS-37 SS-19 SS-30	985 3100* 34 400* nd 1300 4300*	B-B1 B-B1 B-B1 B-B1 B-B1 B-B1 B-B1	nd(200) 24000 nd(20) x nd(500) x x	22J 24 450 120 5J 330 1300	5.9J 2.5J nd(0.2) 12J nd(10) 3.8J 20	570 45 nd(0.2) 150 nd(10) 91 470J	410J 7.7 nd(0.2) 87 nd(10) 27 280J

## NOTES

Pentachlorophenol is also analyzed as an SVOC

blank = no information, may not have been analyzed

nd(#\*) = analyzed and not detected at detection limit of #

x = not analyzed

J = present, concentration estimated, typically because below contract required detection limit

D = Sample diluted to bring concentration within calibration limits

\* = Duplicate analysis not within control limits

# = Weston (1987) sample

Y = Yes, release occurred from Site to ground water

Y\* = Release likely based on ground-water concentrations, but substance not assayed in waste and soil

N = No release to ground water, based on lack of detection ground-water samples

? = Release ambiguous because present in ground water, but not detected in waste or soil

B = Release ambiguous because present in background at similar concentrations

?? = Release ambiguous because detected in ground water only below background detection limit

f:dg = Degradation product of released compound





Table 3.3 Site H Chemical Maxima

Chemical	Number of Samples	WASTE AND SOIL			GROUND WATER				BEDROCK		BACKGROUND (ug/l)	RELEASED FROM SITE To GW?	Chemical	
		WASTE & SOIL E&E (1987) (mg/kg)	TCLP LEACHATE OBG (1999) (ug/l)	Station	SHU (ug/l)	Station	MHW (ug/l)	OBG (2000) Station	DHU (ug/l)	Station				Station
Herbicides, Pesticides	2,4-D	x	420	H-B3	190	EE-02	nd(1 to 2.5)	H-S1	11	H-S1	0.74J	BR-H		Herbicides, Pesticides
	4,4'-DDT	0.92	x	H-5	nd		4.4JD	H-S1	1.2JD	H-S1	nd(0.1)		Y	
	4,4'-DDE	0.78	x	H-8	nd		0.12J	H-S1	0.16J	H-S1	nd(0.1)		Y	
	MCPP[2-(4-chloro-2-methylphenoxy)propanoate]	x	x		nd		3600J	H-S1	4400D	H-S1	nd(120)		Y*	
PCBs	Pentachlorophenol	nd	450	H-B4	4300D/2400	EE-01	4.2J	H-S1	7100/3200	H-S1	0.12J	BR-H	Y	Pentachlorophenol 2,4,5-T
	2,4,5-T	x	x		36J	EE-02	nd(1 to 2.5)		nd		nd(0.5)		Y*	
PCBs	Aroclor 1248	nd	x											PCBs
	Aroclor 1254	nd	x											
	Aroclor 1260	18000	H-4											
	Total PCBs		x		nd		9.82	H-S1	12	H-S1	0.11	BR-H	Y	
Metals	Chromium	100	H-1	nd(200)	4.2J	EE-01	nd(4 to 10)	H-S1	110J	H-S1	nd(10)	BR-H	EE-04*	Metals
	Lead	4500r	H-4	40000	nd(5 to 9)	EE-02	nd(5)	H-S1	8.2	H-S1	2J	BR-H	EE-04*	
	Mercury	3.9	H-4	nd(20)	0.09J	EE-02	nd(0.2)	H-S1	0.2J	H-S1	nd(0.2)	BR-H	EE-04*	
	Molybdenum	x			10	EEG-110	5.1J	H-S1	130	H-S1	4.3J	BR-H	EE-04*	
	Nickel	15000	H-1	x	670	EE-01	720J	H-S1	260J	H-S1	9600	BR-H	EE-04	
	Selenium	2	H-1	nd(500)	7.7J	EE-02	nd(10)		nd(10)		nd(10)		Y	
Metals	Vanadium	95	H-1	x	3.6J	EE-02	6.8J	H-S1	6.6J	H-S1	nd(10)	BR-H	EE-04*	Nickel Selenium Vanadium Zinc
	Zinc	40000	H-1	x	540	EEG-110	nd(35 to 54)		1000J	H-S1	25J	BR-H	EE-04*	

NOTES

Pentachlorophenol also was analyzed as an SVOC  
blank = no information, may not have been analyzed  
nd(uf) = analyzed and not detected at detection limit of #  
x = nd analyzed  
J = present, concentration estimated, typically because below contract required detection limit  
D = Sample diluted to bring concentration within calibration limits  
r = Spike sample recovery not within control limits  
Y = Yes, release occurred from Site to ground water  
Y\* = Release likely based on ground-water concentrations, but substance not assayed in waste and soil  
N = No release to ground water, based on lack of detection in ground water samples  
? = Release ambiguous because present in ground water, but not detected in waste or soil  
B = Release ambiguous because present in background at similar concentrations  
?? = Release ambiguous because detected in ground water only below background detection limit  
Degr = Degradation product of released compound

Table 3.4 Site 1 Chemical Maxima

Chemical	WASTE AND SOIL				GROUND WATER				BEDROCK		RELEASED FROM SITE To GW?	Chemical		
	SUBSURFACE SOIL		TCIP LEACHATE		SHU (ug/l)	Station	MHU (ug/l)	OBG (2000) Station	DHU (ug/l)	Station			(ug/l)	Station
	E&E (1987)	Station	ORG (1999)	Station										
	(mg/kg)	(ug/l)	(ug/l)											
	Number of Samples													
4														
VOCs													VOCs	
Benzene	24	15	760	B5	750	EE-14	300	I-S2	140J	I-S1	63	BR-1	Benzene	
Chlorobenzene	130	13	8900	B2	8700 / 3800	I-S1 / EE-14	20000	I-S1	34000	I-S1	240	BR-1	Chlorobenzene	
Chloroform	nd		2900	B2	nd		nd		nd(5)		nd(25)		Chloroform	
Cis or Trans 1,2-dichloroethene	0.003J	17	x		1200 / 180	I-S1 / EE-14	1400	I-S3	1J	I-S1	nd(25)		Cis or Trans 1,2-dichloroethene	
Ethylbenzene	15	11	x		870 / 83J	I-S1 / EE-14	270	I-S1	74	I-S1	390	BR-1	Ethylbenzene	
4-methyl-2-pentanone	42	16	x		nd		nd	I-S2	nd(25)		nd(120)		4-methyl-2-pentanone	
Tetrachloroethene	53	12	290	B2	74J / nd	I-S2	83J	I-S2	66J	I-S2	20J	BR-1	Tetrachloroethene	
Toluene	78	19	x		42J	EE-14	86J	I-S1	27J	I-S3	44	BR-1	Toluene	
Trichloroethene	38	15	63J	B2	180 / nd	I-S2	26J	I-S2	91	I-S3	37J	BR-1	Trichloroethene	
Vinyl chloride	nd		nd(40)		970 / nd	I-S1	320	I-S1	130	I-S3	nd(50)		Vinyl chloride	
Xylenes, total	19	11	x		nd		23J	I-S1	18	I-S4	38	BR-1	Xylenes, total	
SVOCs													SVOCs	
Acenaphthene	14	16	x		nd(10)	I-S1 / EE-14	1700D	I-S1	100	I-S3	130J	BR-1	Acenaphthene	
Acenaphthylene	nd		x		nd(10)	EE-14	84	I-S2	52	I-S1	nd(1000)		Acenaphthylene	
Anthracene	200	15	x		nd(10)	I-S2	31J	I-S4	nd(10)		130J	BR-1	Anthracene	
Benzo(a)anthracene	67J	110	x		0.50J / nd	I-S2	23J	I-S4	nd(10)		400J	BR-1	Benzo(a)anthracene	
Benzo(b)fluoranthene	32J	16	x		0.3J / nd	I-S3	36J	I-S4	0.42J	I-S4	280J	BR-1	Benzo(b)fluoranthene	
Benzo(k)fluoranthene	nd		x		1.2J / nd	I-S2	4J	I-S4	nd(10)		220J	BR-1	Benzo(k)fluoranthene	
Benzo(a)pyrene	2.5	11	x		0.98J / nd	I-S2	34J	I-S4	0.63J	I-S2	380J	BR-1	Benzo(a)pyrene	
Carbazole	x		x		26	EE-14	13	I-S1	13	I-S1	240J	BR-1	Carbazole	
4-Chloroaniline	43J	15	x		4100J / 1800D	I-S1 / EE-14	1700D	I-S1	100	I-S3	nd(2000)		4-Chloroaniline	
2-Chlorophenol	nd		x		27	EE-14	84	I-S2	52	I-S1	nd(1000)		2-Chlorophenol	
Chrysene	56	17	x		0.73J / nd	I-S2	31J	I-S4	nd(10)		740J	BR-1	Chrysene	
1,2-Dichlorobenzene	320	12	x		500D	EE-14	290J	I-S1	500	I-S1	1200J	BR-1	1,2-Dichlorobenzene	
1,3-Dichlorobenzene	70	19	x		120 / 45	I-S2 / EE-14	150J	I-S1	150J	I-S1	1100	BR-1	1,3-Dichlorobenzene	
1,4-Dichlorobenzene	1800	111	1500		14000D	EE-14	10000D	I-S1	9700	I-S1	51000D	BR-1	1,4-Dichlorobenzene	
2,4-Dichlorophenol	9J	110	x		6.6J / nd	I-S2	42	I-S1	47J	I-S1	2400	BR-1	2,4-Dichlorophenol	
Fluoranthene	200	15	x		nd(10)		22J	I-S1	nd(10)		170J	BR-1	Fluoranthene	
Fluorene	35J	16	x		nd(1)		54J	I-S2	0.58J	I-S3	360	BR-1	Fluorene	
Indeno(1,2,3-cd)pyrene	nd		x		nd(10)		0.92J	I-S4	0.66J	I-S2	240J	BR-1	Indeno(1,2,3-cd)pyrene	
2-Methylnaphthalene	170	16	x		42J	EE-14	nd(10)	I-S4	5.6J	I-S4	670J	BR-1	2-Methylnaphthalene	
2-Methylphenol	nd		x		21	EE-14	3J	I-S1	nd(10)		nd(1000)		2-Methylphenol	
3- or 4-Methylphenol	nd	4-MP only	150	B5	110	EE-14	17J	I-S2	nd(10)		nd(1000)		3- or 4-Methylphenol	
Naphthalene	510	19	x		36	EE-14	38	I-S2	1400D	I-S4	5800	BR-1	Naphthalene	
2-Nitroaniline	nd		x		nd(50)		nd(50)	I-S2	nd(5000)		nd(5000)		2-Nitroaniline	
4-Nitroaniline	nd		x		nd(50)		nd(50)	I-S2	nd(5000)		nd(5000)		4-Nitroaniline	
Nitrobenzene	nd		x		nd(3.5)		nd(3.5)	I-S1	nd(3.5)		140J	BR-1	Nitrobenzene	
Phenanthrene	100J	16	x		nd(10)		89J	I-S1	1.3J	I-S1	790J	BR-1	Phenanthrene	
Phenol	27J	12	x		17	EE-14	6J	I-S2	2.1J	I-S4	180J	BR-1	Phenol	
Pyrene	49J	16	x		nd(10)		nd(10)	I-S2	nd(10)		540J	BR-1	Pyrene	
1,2,4-Trichlorobenzene	8300E	15	x		5100D	EE-14	nd(10)	I-S1	2700	I-S1	1100000D	BR-1	1,2,4-Trichlorobenzene	
2,4,5-Trichlorophenol	nd		x		1.6J	EE-14	nd(10)	I-S1	1.8	I-S1	nd(1000)		2,4,5-Trichlorophenol	
2,4,6-Trichlorophenol	nd		x		15	EE-14	nd(2.1)	I-S1	nd(2.1)		1700	BR-1	2,4,6-Trichlorophenol	

Table 3-4 Site 1 Chemical Maxima

Chemical	WASTE AND SOIL				GROUND WATER				BEDROCK		BACKGROUND (ug/l)	Station	RELEASED FROM SITE To GW?	Chemical		
	SUBSURFACE SOIL E&E (1987)		TCLP LEACHATE OBG (1999)		SHU (ug/l)	Station	MHU (ug/l)	OBG (2000)		DHU (ug/l)					Station	
	(mg/kg)	Station	(ug/l)	Station												
Number of Samples																
Herbicides, Pesticides	2,4-D	x	140	B2	0.27J / nd	I-S2	2.3J	I-S2	11D	I-S1	18	BR-1	nd(0.5)	Herbicides, Pesticides 2,4-D 4,4'-DDT 4,4'-DDE 4,4'-DDE MCP Pentachlorophenol 2,4,5-T		
	4,4'-DDT	43	19	x	0.0022J / nd	I-S1	0.0024J	I-S1	nd(0.1)	nd(50)			nd(0.1)			
	4,4'-DDE	nd	x	x	0.18J	EE-14	0.0024J	I-S1	nd(0.1)	nd(50)			nd(0.1)			
	2,2-methylphenyl-propanate	x	x	x	nd(120)		260J	I-S2	640J	I-S1	18000JD	BR-1	nd(120)			
	Pentachlorophenol	190	3800	B2	500D	EE-14	nd(5)	nd(0.5)	370J	I-S1	900D	BR-1	nd(1)			
	2,4,5-T	x	x	x	nd(0.5)		nd(0.5)	5.8J	I-S1	16		BR-1	0.21J	EE-20	Y*	
PCBs	Aroclor 1248		x											PCBs Aroclor 1248 Aroclor 1254 Aroclor 1260 Total PCBs		
	Aroclor 1254		x													
	Aroclor 1260	15	x													
	Total PCBs	340J	x		0.88	EE-14	0.2	I-S3	0.26	I-S1	15750	BR-1	nd		Y	
Metals	Chromium	730	16	nd(200)	13J	EE-15	50J	I-S4	I-S3	200	14J	BR-1	180J	Metals Chromium Lead Mercury Molybdenum Nickel Selenium Vanadium Zinc		
	Lead	23000	111	16000	22J	EE-14	19J	I-S2	I-S2	4100	5.2	BR-1	22			
	Mercury	240R	111	nd(0.2)	0.18J	EE-14	nd(0.2)	I-S2	I-S2	0.54	nd(0.2)	BR-1	nd(0.2)			
	Molybdenum	x	x	x	11 / nd	I-S3	18	I-S4	I-S3	36	5.2J	BR-1	49			
	Nickel	2400	15	x	7800 / 150	I-S2 / EE-14	630	I-S2	I-S3	2700	39J	BR-1	62			
	Selenium	1300	111	nd(10)	nd(10)		nd(10)		nd(10)	nd(10)			nd(10)			
	Vanadium	550	11	x	27J	EE-15	20	I-S3	I-S1	50	3.6J	BR-1	54			
	Zinc	6300	11	x	33000J / 93	I-S2 / EE-14	3600J	I-S2	I-S2	6300J	9.2J	BR-1	1000			
															EE-04*	Y
															EE-04*	N
													EE-04*	B		
													EE-20	Y		

NOTES

Pentachlorophenol is also analyzed as an SVOC  
blank = no information, may not have been analyzed  
nd(1) = analyzed and not detected at detection limit of #  
x = nd analyzed  
J = present, concentration estimated, typically because below contract required detection limit  
D = Sample diluted to bring concentration within calibration limits  
Y = Yes, release occurred from Site to ground water  
Y\* = Release likely based on ground-water concentrations, but substance not assayed in waste and soil  
N = No release to ground water, based on lack of detection in ground-water samples  
7 = Release ambiguous because present in ground water, but not detected in waste or soil  
B = Release ambiguous because present in background at similar concentrations  
Degl = Degradation product of released compound  
-- Where the maximum occurs at a station downgradient of C.S.A. the maximum of stations upgradient of C.S.A. is given after the "r"

Table 3.5 Site L Chemical Maxima

Chemical	WASTE AND SOIL				SUBSURFACE SOIL				TCLP LEACHATE				GROUND WATER				RELEASED FROM SITE To GW?	Chemical
	SOIL (EPA (1981) (mg/kg)	Station	E&E (1987) (mg/kg)	Station	G&M (1991) (mg/kg)	Station	OBG (1999) (mg/kg)	Station	G&M (1991) (ug/l)	Station	OBG (1999) (ug/l)	Station	SHU (ug/l)	Station	OBG (ug/l)	Station		
Number of Samples																		
VOCs	Benzene	4.2	L3-04	5.7J	L2(LB-13)	0.026	L-B1-12-14	nd(20)	41	GML1(LB-16/17)	nd(20)	32	44	EEG-109	0.99J	EEG-108	Y	Benzene
	Chlorobenzene	nd	L3-04	5.3J	L1(LB16/17)	0.024	L-B1-12-14	nd(20)	41	GML1(LB-16/17)	nd(20)	32	2.8J	EEG-109	nd(5)	EEG-108	Y	Chlorobenzene
	Chloroform	20	L3-04	nd		nd(0.045)		nd(20)			nd(20)		76	EEG-109	nd(5)		Y	Chloroform
	Cis or Trans 1,2-dichloroethene	nd				nd(0.045)		x	x		x		nd(5)		nd(5)		N	Cis or Trans 1,2-dichloroethene
	Ethylbenzene	0.04J	L2-03	nd		0.023J	L-B1-12-14	x	x		x		nd(5)		nd(5)		N	Ethylbenzene
	4-methyl-2-pentanone	0.17	L2-03	nd		0.022J	L-B1-12-14	x	x		x		50	EEG-109	nd(25)		Y	4-methyl-2-pentanone
	Tetrachloroethene	nd	L3-04	nd		nd(0.045)		nd(20)			72		nd(5)		nd(5)		N	Tetrachloroethene
	Toluene	27	L3-04	400J	L2(LB-13)	0.043	L-B1-12-14	x	x		x		nd(5)		nd(5)		N	Toluene
	Trichloroethene	nd		nd		nd(0.045)		nd(20)			12J	B1	1.6J	EEG-109	0.57J	EEG-108	B	Trichloroethene
	Vinyl chloride	nd		nd		nd(0.089)		nd(40)			nd(40)		nd(10)		nd(10)		N	Vinyl chloride
SVOCs	Xylenes, total	0.67J	L3-04	11J	L2(LB-17)	0.055	L-B1-12-14	x	x		x		3.8J	EEG-109	nd(5)		Y	Xylenes, total
	Acenaphthene	0.044J	L2-03	3.1J	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Acenaphthene
	Acenaphthylene	nd		0.28J	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Acenaphthylene
	Anthracene	nd		4.2	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Anthracene
	Benzo(a)anthracene	0.91J	L3-04	8.6	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Benzo(a)anthracene
	Benzo(b)fluoranthene	nd		5.4	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Benzo(b)fluoranthene
	Benzo(k)fluoranthene	nd		4.6	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Benzo(k)fluoranthene
	Benzo(e)pyrene	nd		5.3	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Benzo(e)pyrene
	Carbazole	x				x		x	x		x		nd(10)		nd(10)		N	Carbazole
	4-Chloroaniline	nd		270E	L1(LB-17)	x		x	x		x		55	EEG-109	nd(20)		Y	4-Chloroaniline
SVOCs	2-Chlorophenol	2.2	L3-04	2.6J	L2(LB-13)	x		x	x		x		21	EEG-109	nd(10)		Y	2-Chlorophenol
	Chrysene	0.21J	L2-03	8.2	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Chrysene
	1,2-Dichlorobenzene	nd		7.7	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	1,2-Dichlorobenzene
	1,3-Dichlorobenzene	nd		4.3	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	1,3-Dichlorobenzene
	1,4-Dichlorobenzene	0.22J	L3-04	100D	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	1,4-Dichlorobenzene
	2,4-Dichlorophenol	nd		11	L2(LB-13)	x		x	x		x		26	EEG-109	nd(10)		Y	2,4-Dichlorophenol
	Fluoranthene	0.45	L3-02	16	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Fluoranthene
	Fluorene	nd		5	L1(LB-18/17)	x		x	x		x		nd(1)		nd(1)		N	Fluorene
	Indeno(1,2,3-cd)pyrene	nd		2.9J	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Indeno(1,2,3-cd)pyrene
	2-Methylnaphthalene	1.0J	L3-04	3.1J	L2(LB-13)	x		x	x		x		nd(10)		nd(10)		N	2-Methylnaphthalene
SVOCs	2-Methylphenol	nd				nd(50)		nd(50)			nd(50)		nd(10)		nd(10)		N	2-Methylphenol
	3- or 4-Methylphenol	1.1J (4-MP)	L3-04	7.1 (4-MP)	L2(LB-13)	x		190	GML1(LB-17)	190	B4		5.5J	EEG-109	nd(10)		Y	3- or 4-Methylphenol
	Naphthalene	0.53J	L3-04	7.3	L1(LB-16/17)	x		x	x		x		28	EEG-109	nd(10)		Y	Naphthalene
	2-Nitroaniline	nd		x		x		x	x		x		nd(50)		nd(50)		N	2-Nitroaniline
	4-Nitroaniline	nd		x		x		x	x		x		nd(50)		nd(50)		N	4-Nitroaniline
	Nitrobenzene	nd		x		x		nd(50)			nd(50)		nd(3.5)		nd(3.5)		N	Nitrobenzene
	Phenanthrene	1.8J	L3-04	23	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Phenanthrene
	Phenol	1.5J	L3-04	16	L2(LB-13)	x		x	x		x		nd(10)		nd(10)		N	Phenol
	Pyrene	0.28	L2-03	23	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	Pyrene
	1,2,4-Trichlorobenzene	nd		79D	L1(LB-18/17)	x		x	x		x		nd(10)		nd(10)		N	1,2,4-Trichlorobenzene
SVOCs	2,4,5-Trichlorophenol	nd		ND	L1(LB-18/17)	x		nd(250)			nd(50)		nd(10)		nd(10)		N	2,4,5-Trichlorophenol
	2,4,6-Trichlorophenol	nd		1.5J	L1(LB-18/17)	x		nd(250)			nd(50)		nd(2.1)		nd(2.1)		N	2,4,6-Trichlorophenol

Table 3.5 Site L Chemical Maxima

Chemical	WASTE AND SOIL		SUBSURFACE SOIL		TCLP LEACHATE		GROUND WATER		RELEASED FROM SITE To GW?	Chemical
	SOIL IEPA (1981) (mg/kg)	Station	E&E (1987) (mg/kg)	Station	G&M (1991) (mg/kg)	Station	TCLP LEACHATE OBG (1999) (ug/l)	Station	SHU (ug/l)	
Herbicides, Pesticides										Herbicides, Pesticides
2,4-D										2,4-D
4,4'-DDT										4,4'-DDT
4,4'-DDE										4,4'-DDE
MCPP[2-(4-chloro-2-methylphenoxy)-propanoate]										4,4'-DDE
Pentachlorophenol										MCPP
2,4,5-T										Pentachlorophenol
PCBs										PCBs
Aroclor 1248										Aroclor 1248
Aroclor 1254										Aroclor 1254
Aroclor 1260										Aroclor 1260
74										Total PCBs
Metals										Metals
Chromium										Chromium
Lead										Lead
Mercury										Mercury
Molybdenum										Molybdenum
Nickel										Nickel
Selenium										Selenium
Vanadium										Vanadium
Zinc										Zinc

NOTES

Pentachlorophenol is also analyzed as an SVOC.  
blank = no information, may not have been analyzed  
nd(#)= analyzed and not detected at detection limit of #  
x = not analyzed  
J = present, concentration estimated, typically because below contract required detection limit  
D = Sample diluted to bring concentration within calibration limits  
Y = Yes, release occurred from Site to ground water  
Y\* = Release likely based on ground-water concentrations, but substance not assayed in waste and soil  
N = No release to ground water, based on lack of detection in ground-water samples  
? = Release ambiguous because present in ground water, but not detected in waste or soil  
B = Release ambiguous because present in background at similar concentrations

Table 3.6 Site M Chemical Maxima

Chemical	Number of Samples	SEDIMENT				SEDIMENT LEACHATE (TCLP) DBG (1999) Station 4	RELEASE FROM SITE To GW?	GROUND WATER	
		IEPA (1980, 1981) (mg/kg)	E&E (1986) (mg/kg)	C&M (1991) (mg/kg)	Station			SGW-S1 (max) (ug/l)	TS-S1 (max) (ug/l)
VOCs									
	Benzene			nd(2.6J)	M3			nd(1.2)	nd(1.2)
	Chlorobenzene	nd	nd	10J		1.2J B4	Y	nd(5)	nd(5)
	Chloroform	nd	nd	nd(2.6J)		M1,M2,M3 B1	Y	nd(5)	nd(5)
	Cis or Trans 1,2-dichloroethene	nd	nd			nd(20)	N	nd(5)	nd(5)
	Ethylbenzene	nd	nd	0.82J	M3	x	Y	nd(5)	nd(5)
	4-methyl-2-pentanone	nd	nd			x	N	nd(25)	nd(25)
	Tetrachloroethene	nd	nd	nd(2.6J)		nd(20)	N	nd(5)	nd(5)
	Toluene	nd	nd	nd(2.6J)		x	N	nd(5)	nd(5)
	Trichloroethene	nd	nd			21 B2	Y	nd(2.7)	nd(2.7)
SVOCs	Vinyl chloride	nd	nd			nd(40)	N	nd(10)	nd(10)
	Xylenes, Total	nd	nd	nd(2.6J)		x	N	nd(5)	nd(5)
	Acenaphthene	nd	nd	1.5J	M-4A	x	Y	nd(10)	nd(10)
	Acenaphthylene	nd	nd	nd(14)		x	N	nd(10)	0.87J
	Anthracene	nd	nd	3.9J	M-4A	x	N	nd(10)	nd(10)
	Benzo(a)anthracene	nd	nd	9.4J	M3	x	Y	nd(10)	0.52J
	Benzo(b)fluoranthene	nd	nd	15	M3	x	Y	nd(10)	0.44J
	Benzo(k)fluoranthene	nd	nd	9.3J	M3	x	Y	nd(10)	nd(10)
	Benzo(a)pyrene	nd	nd	7.5J	M3	x	Y	nd(10)	0.49J
	Carbazole	x		x		x	N	nd(10)	nd(10)
	4-Chloroaniline	nd	nd	nd(14)		x	N	nd(20)	nd(20)
	2-Chlorophenol	nd	nd	nd(14)		x	N	nd(10)	nd(10)
	Chrysene	nd	nd	12	M3	x	Y	nd(10)	0.7J
	1,2-Dichlorobenzene	nd	nd	26	M3	x	Y	nd(10)	nd(10)
	1,3-Dichlorobenzene	nd	nd	4.1J	M3	x	Y	nd(10)	nd(10)
	1,4-Dichlorobenzene	nd	nd	40	M3	nd(50)	Y	nd(10)	0.38J
	2,4-Dichlorophenol	nd	nd	nd(14)		31J B1	N	nd(10)	nd(10)
	Fluoranthene	nd	nd	21	M3,M-4A	x	Y	nd(10)	nd(10)
	Fluorene	nd	nd	5.9J	M-4A	x	Y	nd(1)	1.6
	Indeno(1,2,3-cd)pyrene	x	x	4.4J	M-4A	x	Y	nd(10)	0.68J
	2-Methylnaphthalene	nd	nd	6.9J	M3	x	Y	nd(10)	nd(10)
	2-Methylphenol	nd	nd	x		nd(50)	N	nd(10)	nd(10)
	3- or 4-Methylphenol	nd (4-MP)	nd (14) (4MP)			nd(50)	N	nd(10)	nd(10)
	Naphthalene	nd	nd	3.3J	M3	x	Y	nd(10)	nd(10)
	2-Nitroaniline	nd	nd	x		x	N	nd(50)	nd(50)
	4-Nitroaniline	nd	nd	x		x	N	nd(50)	nd(50)
	Nitrobenzene	nd	nd	x		nd(50)	N	nd(3.5)	nd(3.5)
	Phenanthrene	nd	nd	13J	M-4A	x	Y	nd(10)	nd(10)
	Phenol	nd	nd	nd(14)		x	N	nd(10)	nd(10)
	Pyrene	nd	nd	27	M-4A	x	Y	nd(10)	nd(10)
	1,2,4-Trichlorobenzene	nd	nd	14	M3	x	Y	nd(10)	nd(10)
	2,4,5-Trichlorophenol	nd	nd	nd(59)		nd(50)	N	nd(10)	nd(10)
	2,4,6-Trichlorophenol	nd	nd	nd(14)		nd(50)	N	nd(2.1)	nd(2.1)

Table 3.6 Site M Chemical Maxima

Chemical	Number of Samples	SEDIMENT				SEDIMENT LEACHATE (ICLIP)		RELEASE FROM SITE To GW?	GROUND WATER	
		IEPA (1980, 1981) (mg/kg)	Station	E&E (1986) (mg/kg)	Station	G&M (1991) (mg/kg)	Station		SGW-S1 (max) (ug/l)	TS-S1 (max) (ug/l)
Herbicides Pesticides	2,4-D									
	4,4'-DDT			nd		nd(50)	nd(25)	x	nd(0.5)	nd(0.5)
	4,4'-DDE			nd		x	x	N	nd(0.1)	nd(0.1)
	MCPPI[2-(4-chloro-2-methylphenoxy)-propanoate]			x		x	x	N	nd(0.1)	nd(0.1)
PCBs	Pentachlorophenol			nd		nd(250)	nd(250)	x	nd(120)	nd(120)
	2,4,5-T			nd	nd(69)	x	x	N	nd(1)	nd(5)
PCBs	Aroclor 1242			20	x	x	x	Y		
	Aroclor 1248			88	260	x	x	Y		
	Aroclor 1254			42	190	x	x	Y		
	Aroclor 1260			27J	72J	x	x	Y		
	Total PCBs	1100	x123	36	505	x	x	Y	0.056	nd
Metals	Chromium	150	x123	53	SD-17	183	M3	B	82J	97J
	Lead	1400	x123	71	SD-17	1910	M3	Y	3	14
	Mercury	x		0.56	SD-16	0.45	M3	B	36J	0.0091J
	Molybdenum	x		x		x		x	13	nd(10)
	Nickel	1600	x123	356R	SD-15	2490	M3	Y	59	34J
	Selenium	x		nd		nd(500)		N	nd(10)	nd(10)
	Vanadium	42	x123	19	SD-15	37.7	M3	B	57J	12
	Zinc	17700	x123	1010	SD-17	31600	M3	Y	170	49

NOTES

Pentachlorophenol is also analyzed as an SVOC  
blank = no information, may not have been analyzed  
nd(4) = analyzed and not detected at detection limit of #  
x = not analyzed  
J = present, concentration estimated, typically because below contract required detection limit  
R = Spike sample recovery not within control limits  
Y = Yes, release occurred from Site to ground water  
N = No release to ground water, based on lack of detection in ground water samples  
B = Release ambiguous because present in background at similar concentrations



Chemical	SOIL			
	SUBSURFACE SOIL		TCLP LEACHATE	
	E&E (1986)		OBG (1999)	
	(mg/kg)	Station	(ug/l)	Station
<b>VOCs</b>				
Benzene	nd		13J	B3
Chlorobenzene	nd		nd(20)	
Chloroform	nd		nd(20)	
Cis or Trans 1,2-dichloroethene	nd		x	
Ethylbenzene	nd		x	
4-methyl-2-pentanone	4J	N1-05	x	
Tetrachloroethene	nd		nd(20)	
Toluene	nd		x	
Trichloroethene	nd		2.4J	B4
Vinyl chloride	nd		nd(40)	
Xylenes, total	nd		x	
<b>SVOCs</b>				
Acenaphthene	nd		x	
Acenaphthylene	nd		x	
Anthracene	nd		x	
Benzo(a)anthracene	0.26J	N1-05	x	
Benzo(b)fluoranthene	0.29J	N1-05	x	
Benzo(k)fluoranthene	nd		x	
Benzo(a)pyrene	0.211J	N1-05	x	
Carbazole	x		x	
4-Chloroaniline	nd		x	
2-Chlorophenol	nd		x	
Chrysene	0.28J	N1-05	x	
1,2-Dichlorobenzene	nd		x	
1,3-Dichlorobenzene	nd		x	
1,4-Dichlorobenzene	nd		nd(50)	
2,4-Dichlorophenol	nd		x	
Fluoranthene	0.68	N1-05	x	
Fluorene	nd		x	
Indeno(1,2,3-cd)pyrene	nd		x	
2-Methylnaphthalene	nd		x	
2-Methylphenol	nd		nd(50)	
3- or 4-Methylphenol	nd(4MP)		nd(50)	
Naphthalene	nd		x	
2-Nitroaniline	nd		x	
4-Nitroaniline	nd		x	
Nitrobenzene	nd		nd(50)	
Phenanthrene	0.43	N1-05	x	
Phenol	nd		x	
Pyrene	0.53	N1-05	x	
1,2,4-Trichlorobenzene	nd		x	
2,4,5-Trichlorophenol	nd		nd(50)	
2,4,6-Trichlorophenol	nd		nd(50)	

		SOIL			
		SUBSURFACE SOIL		TCLP LEACHATE	
		E&E (1986)		OBG (1999)	
		(mg/kg)	Station	(ug/l)	Station
Chemical					
Herbicides, Pesticides					
	2,4-D	x		nd(25)	
	4,4'-DDT	nd		x	
	4,4'-DDE	nd		x	
	MCPPP[2-(4-chloro-2-methylphenoxy)-propionate]	x		x	
	Pentachlorophenol	nd		nd(250)	
	2,4,5-T	x		x	
PCBs					
	Aroclor 1248	nd		x	
	Aroclor 1254	nd		x	
	Aroclor 1260	nd		x	
	Total PCBs	nd		x	
Metals					
	Chromium	13	NB-07	nd(200)	
	Lead	78*	NB-07	46J	B3
	Mercury	9	N2-06	nd(20)	
	Molybdenum	x		x	
	Nickel	18	NB-07	x	
	Selenium	nd		nd(500)	
	Vanadium	21	NB-07	x	
	Zinc	182	NB-07	x	

NOTES

Pentachlorophenol is also analyzed as an SVOC.

blank = no information, may not have been analyzed

nd(#) = analyzed and not detected at detection limit of #

x = not analyzed

J = present, concentration estimated, typically because below contract required detection limit

D = Sample diluted to bring concentration within calibration limits

\* = Duplicate analysis not within control limits

Table 3 8 Site CS-A Chemical Maxima

Chemical	SURFACE WATER				SEDIMENT				GROUND WATER				RELEASED FROM SITE To GW?	Chemical
	IEPA (1980)		E&E (1986)		IEPA (1980 & 1981)		E&E (1986)		EE-15 (1987)		BACKGROUND			
	(ug/l)	Station	(ug/l)	Station	(mg/kg)	Station	(mg/kg)	Station	(ug/l)	Station	(ug/l)	Station		
VOCs	Benzene	x	1J	SW-12	x	nd	8.8J	A16C	5	4	6.7	EE-04*	Y	Benzene
	Chlorobenzene	x	2J	SW-12	x	0.48J	SD-36	A16B	120	200	nd(5)	EE-04*	Y	Chlorobenzene
	Chloroform	x	25	SW-11	x	nd	nd	A16B	nd(10)	nd(10)	nd(5)	EE-04*	Y*	Chloroform
	Cis or Trans 1,2-dichloroethene	x	nd		x	nd	15	A16B	310	66	nd(5)	EE-04*	Y	Cis or Trans 1,2-dichloroethene
	Ethylbenzene	x	nd		x	nd	80	A16B	nd	nd(10)	1.6J	EE-04*	Y	Ethylbenzene
	4-methyl-2-pentanone	x	6J	SW-12	x	0.93Jb	SD-34	nd	nd	nd(50)	nd(25)	EE-04*	Y	4-methyl-2-pentanone
	Tetrachloroethene	x	nd		x	nd	11J	A16C	nd	nd(10)	nd(5)	EE-04*	Y	Tetrachloroethene
	Toluene	x	nd		x	nd	7.2J	A16B	nd	nd(10)	nd(5)	EE-04*	Y	Toluene
	Trichloroethene	x	16	SW-13	x	nd	100	A16B	4J	0.72J	nd(2.7)	EE-04*	Y	Trichloroethene
	Vinyl chloride	x	nd		x	nd	nd	nd	76	nd(10)	nd(10)	EE-04*	Degr	Vinyl chloride
Xylenes, total	x	nd		x	nd	500	A16B	nd	nd(10)	11	EE-04*	Y	Xylenes, total	
SVOCs	Acenaphthene	x	nd		x	0.17J	SD-36	nd	nd	nd(10)	8J	EE-20	Y	Acenaphthene
	Acenaphthylene	x	nd		x	nd	nd	nd	nd	nd(10)	nd(10)	EE-20	N	Acenaphthylene
	Anthracene	x	nd		x	nd	nd	nd	2JB	nd(10)	nd(10)	EE-20	N	Anthracene
	Benzo(a)anthracene	x	nd		x	nd	nd	nd	nd	nd(10)	0.97J	EE-20	N	Benzo(a)anthracene
	Benzo(b)fluoranthene	x	nd		x	1.0J	SD-36	nd	nd	nd(10)	nd(10)	EE-20	Y	Benzo(b)fluoranthene
	Benzo(k)fluoranthene	x	nd		x	nd	nd	nd	nd	nd(10)	nd(10)	EE-20	N	Benzo(k)fluoranthene
	Benzo(a)pyrene	x	nd		x	0.54J	SD-36	nd	nd	nd(10)	nd(10)	EE-20	Y	Benzo(a)pyrene
	Carbazole	x	x		x	x	nd	nd	x	nd(3.4)	nd(10)	EE-20	x	Carbazole
	4-Chloroaniline	x	3J	SW-12	x	0.13J	SD-35	17	A11B	18	7.6J	EE-20	Y	4-Chloroaniline
	2-Chlorophenol	x	nd		x	nd	nd	nd	nd	4.3J	nd(10)	EE-20	Y	2-Chlorophenol
Chrysene	x	nd		x	1.7J	SD-36	5.7J	A16C	nd	1.3J	EE-20	Y	Chrysene	
1,2-Dichlorobenzene	x	nd		x	0.48	SD-32	650b	A16B	4J	24	EE-20	Y	1,2-Dichlorobenzene	
1,3-Dichlorobenzene	x	nd		x	0.55J	SD-36	32J	A16B	nd	11	EE-20	Y	1,3-Dichlorobenzene	
1,4-Dichlorobenzene	x	nd		x	2.9	SD-36	390b	A16B	10	440b	EE-20	Y	1,4-Dichlorobenzene	
2,4-Dichlorophenol	x	nd		x	nd	nd	nd	nd	nd	nd(10)	EE-20	N	2,4-Dichlorophenol	
Fluoranthene	x	nd		x	0.6J	SD-35	8.1J	A21C	nd	nd(10)	EE-20	Y	Fluoranthene	
Fluorene	x	nd		x	nd	nd	0.80J	A13B	nd	nd(10)	EE-20	Y	Fluorene	
Indeno(1,2,3-cd)pyrene	x	nd		x	0.57J	SD-35	nd	nd	nd	nd(10)	EE-20	Y	Indeno(1,2,3-cd)pyrene	
2-Methylnaphthalene	x	nd		x	0.45J	SD-34	0.60J	A11C	nd	nd(10)	EE-20	Y	2-Methylnaphthalene	
2-Methylphenol	x	nd		x	nd	nd	0.6	A23A	nd	nd(10)	EE-20	Y	2-Methylphenol	
3- or 4-Methylphenol	x	nd		x	nd(4MP)	SD-36	0.24	A23A	nd	nd(10)	EE-04*	Y	3- or 4-Methylphenol	
Naphthalene	x	nd		x	1.5J	SD-36	5.6J	A16C	nd	nd(10)	EE-04*	Y	Naphthalene	
2-Nitroaniline	x	nd		x	nd	nd	nd	nd	nd	nd(50)	EE-04*	N	2-Nitroaniline	
4-Nitroaniline	x	nd		x	nd	nd	nd	nd	nd	nd(50)	EE-04*	N	4-Nitroaniline	
Nitrobenzene	x	nd		x	nd	nd	nd	nd	nd	nd(3.5)	EE-04*	N	Nitrobenzene	
Phenanthrene	x	4J	SW-12	x	0.19J	SD-32	14J	A22B	nd	nd(10)	EE-04*	Y	Phenanthrene	
Phenol	x	nd		x	610b	SD-36	10J	A16B	nd	nd(10)	EE-04*	Yb	Phenol	
Pyrene	x	nd		x	1.4J	SD-36	10J	A22B	nd	nd(10)	EE-04*	Y	Pyrene	
1,2,4-Trichlorobenzene	x	nd		x	nd	nd	160b	A16B	nd	nd(10)	EE-04*	Y	1,2,4-Trichlorobenzene	
2,4,5-Trichlorophenol	x	nd		x	nd	nd	nd	nd	nd	nd(10)	EE-04*	N	2,4,5-Trichlorophenol	
2,4,6-Trichlorophenol	x	nd		x	nd	nd	nd	nd	nd	nd(10)	EE-04*	N	2,4,6-Trichlorophenol	

Table 3.8 Site CS-A Chemical Maxima

Chemical	SURFACE WATER			SEDIMENT				GROUND WATER		RELEASED FROM SITE To GW?	Chemical
	IEPA (1980) (ug/l)	Station	E&E (1986) (ug/l)	Station	IEPA (1980 & 1981) (mg/kg)	Station	E&E (1986) (mg/kg)	Station	E&E (1987) OBG (1999) (ug/l)	Station	
Herbicides, Pesticides	2,4-D	x			x		x		x	nd(0.5)	Herbicides, Pesticides
	4,4'-DDT	x			x		nd		nd	nd(0.1)	2,4-D
	4,4'-DOE	x			x		nd		nd	nd(0.1)	4,4'-DDT
	MC-P[2-(4-chloro-2-methylphenoxy)-propanoate]	x			x		x		x	nd(120)	4,4'-DOE
	Pentachlorophenol	x			x		0.80J	SD-35	7J	nd(1)	MCPP
PCEs	2,4,5-T	x	nd		x		x		x	nd(0.5)	Pentachlorophenol
	Aroclor 1221				x		21	SD-32	nd		2,4,5-T
	Aroclor 1232				x		nd		nd		Aroclor 1221
	Aroclor 1242				x		21	SD-32	nd		Aroclor 1232
	Aroclor 1248				x		21	SD-32	nd		Aroclor 1242
Metals	Aroclor 1254				x		71	SD-35	nd		Aroclor 1248
	Aroclor 1260				x		24	SD-35	nd		Aroclor 1254
	Total PCBs	28	SS04	nd	13	x129	95	SD-35	nd		Aroclor 1260
	Chromium	810	SS03	81	490	SS-1/x129	206	SD-35	nd		Total PCBs
	Lead	6800	SS03	3100	2600	SS-1/x129	2000	SD-34	nd		Aroclor 1221
Metals	Mercury	1.6	SS03,SS04	0.59	100	SS-2/x128	5.6	SD-34	nd		Aroclor 1232
	Molybdenum	x		x	x		x		x	nd(0.2)	Aroclor 1242
	Nickel	4200	SS03	2600	1500	SS-1/x129	765r	SD-32	nd		Aroclor 1248
	Selenium	2	SS03	nd	1.1	SS-2/x128	3.3	SD-33	nd		Aroclor 1254
	Vanadium	x		nd	x		25	SD-35	nd		Aroclor 1260
	Zinc	30000	SS03	1500	5600	SS-1/x129	3420	SD-35	26		Total PCBs
	Chromium				nd				nd		Chromium
	Lead				nd				13J		Lead
	Mercury				nd				nd(5)		Mercury
	Molybdenum				x				0.12J		Molybdenum
Metals	Nickel				x				nd(10)		Nickel
	Selenium				nd				62		Selenium
	Vanadium				x				nd(10)		Vanadium
	Zinc				nd				54		Zinc
					26				1000		

# NOTES

Pentachlorophenol is also analyzed as an SVOC.  
 Blank = no information, may not have been analyzed  
 nd(?) = analyzed and not detected at detection limit of #  
 x = not analyzed  
 J = present, concentration estimated, typically because below contract required detection limit  
 b = Compound detected in blank sample  
 D = Sample diluted to bring concentration within calibration limits  
 \* = Duplicate analysis not within control limits  
 r = Spike sample recovery not within control limits  
 Y = Yes, release occurred from Site to ground water  
 Yb = Tentatively yes, subject to review of blank contamination information  
 N = No release to ground water, based on lack of detection in sediment  
 ? = Release ambiguous because present in ground water, but not detected in waste or soil  
 Degr = Degradation product of released compound

Table 3.9 CS-8 Chemical Maxima

Chemical	SEDIMENT				RELEASE TO GW?	GROUND WATER				Background EEG-108 (max) (ug/l)	
	IEPA (1980-several) (mg/kg)		G&M (1991) (mg/kg)			Middle third of CS-B EEG-103 (ug/l)		Lower third of CS-B EEG-105 SW-S2 (max) (ug/l)			
	Station	(mg/kg)	Station	(mg/kg)		EEG-104 SW-S1 (ug/l)	(max) (ug/l)	SW-S3 (max) (ug/l)	(max) (ug/l)		
VOCs	Benzene	nd	0.087J	SD-14	nd	nd(1.2)	nd(1.2)	nd(1.2)	0.6J [1]	3.3 [2]	0.99J
	Chlorobenzene	nd	5.2	SD-14	13DJ	A-B1	086J	S1	nd(5)	12 [5]	34 [1]
	Chloroform		nd	nd	nd		nd		nd(5)	nd(5)	nd(5)
	Cis or Trans 1,2-dichloroethene		nd	nd	nd		nd		nd(5)	0.52J [2]	0.67J
	Ethylbenzene		3.6	SD-14	0.044J	F-B1	nd		nd(5)	nd(5)	nd(5)
	4-methyl-2-pentanone		0.22J	SD-14			nd		nd(25)	nd(25)	nd(25)
	Tetrachloroethene		nd	0.03J		F-B1	nd		nd(5)	nd(5)	nd(5)
	Toluene	nd	0.81	SD-14	5.3J	B-B1	0.020J	S2	nd(5)	0.54J	0.8J [2]
	Trichloroethene		nd		nd		nd		nd(2.7)	nd(2.7)	nd(2.7)
	Vinyl chloride		nd		nd		nd		nd(10)	nd(10)	nd(10)
SVOCs	Xylenes, total	540	0.99	SD-14	0.36J	B-B1	nd		nd(5)	nd(5)	3.7J [1]
	Acenaphthene		nd		2.6	J-B2	nd		nd(10)	nd(10)	nd(10)
	Acenaphthylene		nd		nd	J-B2	nd		nd(10)	nd(10)	nd(10)
	Anthracene		nd		2.7	J-B2	nd		nd(10)	nd(10)	nd(10)
	Benzo[a]anthracene		0.43J	SD-18	5.4	F-B1	0.96J	S1	nd(10)	nd(10)	nd(10)
	Benzo[b]fluoranthene		3.4J	SD-14	30	A-B1	2.0J	S2	nd(10)	nd(10)	nd(10)
	Benzo[k]fluoranthene		1.5J	SD-18	15	A-B1	1.6J	S2	nd(10)	nd(10)	nd(10)
	Benzo[a]pyrene		1.8J	SD-14	10	A-B1	1.5J	S1	nd(10)	nd(10)	nd(10)
	Carbazole		x		x		nd		nd(10)	nd(10)	nd(10)
	4-Chloroaniline		nd		nd		0.83J	S2	nd(20)	nd(20)	5.3J [2]
SVOCs	2-Chlorophenol	3.7	100301		0.46J	B-B1	nd		nd(10)	0.25J [1]	nd(10)
	Chrysene		1.2J	SD-18	9.4	A-B1	1.8J	S2	nd(10)	nd(10)	nd(10)
	1,2-Dichlorobenzene	80	100301		17J	F-B1	0.37J	S1	nd(10)	nd(10)	nd(10)
	1,3-Dichlorobenzene		nd		2.0	J-B2	nd		nd(10)	nd(10)	nd(10)
	1,4-Dichlorobenzene	370	100301		220	SD-14	12	S1	nd(10)	nd(10)	nd(10)
	Dichlorobenzene	12000	P-1						nd(10)	11 [4]	1.3J [1]
	2,4-Dichlorophenol	1.2	100301		nd		0.88J		nd(10)	nd(10)	nd(10)
	Fluoranthene		11J	SD-14	5.2	F-B1	2.3J	S1	nd(10)	nd(10)	nd(10)
	Fluorene		3.9J	SD-14	4.6	J-B2	nd		nd(1)	nd(1)	nd(1)
	Indeno(1,2,3-cd)pyrene		1.4J	SD-19	9	A-B1	1.3J	S1	nd(10)	nd(10)	nd(10)
SVOCs	2-Methylnaphthalene		8.4J	SD-14	7	J-B2	nd		nd(10)	nd(10)	nd(10)
	2-Methylphenol		nd		nd		nd		nd(10)	nd(10)	nd(10)
	3- or 4-Methylphenol		nd	(4-MP)	0.12J (4-MP)	H-B1	nd		nd(10)	nd(10)	nd(10)
	Naphthalene		9.5J	SD-14	5.1J	A-B1	0.36J	S2	nd(10)	nd(10)	nd(10)
	2-Nitroaniline		nd		x		nd		nd(50)	nd(50)	nd(50)
	4-Nitroaniline		nd		x		nd		nd(50)	nd(50)	nd(50)
	Nitrobenzene		nd		x		nd		nd(3.5)	nd(3.5)	nd(3.5)
	Phenanthrene		15J	SD-14	2.9	J-B2	0.93J	S2	nd(10)	nd(10)	nd(10)
	Phenol		nd		nd		nd		nd(10)	nd(10)	nd(10)
	Pyrene		13J	SD-14	17E	J-B2	3.0J	S1	nd(10)	nd(10)	nd(10)
SVOCs	1,2,4-Trichlorobenzene		5.4J	SD-14	12	F-B1	0.77J	S2	nd(10)	nd(10)	nd(10)
	Trichlorobenzene								nd(10)	nd(10)	nd(10)
	2,4,5-Trichlorophenol		3700	P-1	nd	E-B1	nd		nd(10)	nd(10)	nd(10)
	2,4,6-Trichlorophenol		nd		0.066J	B-B1	nd		nd(10)	nd(10)	nd(10)

Chemical	SEDIMENT				RELEASE TO GW?	GROUND WATER			
	IEPA (1980-several) (mg/kg)	Station	E&E (1986) (mg/kg)	G&M (1991) (mg/kg)		Middle third of CS-B		Lower third of CS-B	
						EEG-103 (ug/l)	EEG-104 (ug/l)	EEG-105 (ug/l)	SW-S3 (max) (ug/l)
Herbicides, Pesticides	2,4-D			x	N	nd(0.5)	nd(0.5)	nd(0.5)	0.3J [1]
	4,4'-DDT		nd	x	N	nd(0.1)	nd(0.1)	nd(0.1)	nd(0.1)
	4,4'-DDE		nd	x	N	nd(0.1)	nd(0.1)	nd(0.1)	nd(0.1)
	MCPPT2-(4-chloro-2-methylphenoxy)-propionate		x	x	N	nd(120)	nd(120)	nd(120)	nd(120)
PCBs	Pentachlorophenol	130	100301	0.94J	SD-19	2.9	B-B1	0.22J	S2
	2,4,5-T			x				nd	
	Aroclor 1248		480	SD-14	440J	C-B1			
	Aroclor 1254		141	SD-19	180J	A-B1			
Metals	Aroclor 1260		66	SD-14	130J	A-B1			
	Total PCBs	17	#20			230	S2		
	Chromium	400	x114	153	SD-14	296	E-B1	78J	S3
	Lead	24000	x107	1460	SD-19	2700	D-B1	1000J	S2
	Mercury	30	x113	1.68	SD-19	5	D-B1	1.5J	S2
	Molybdenum	92	100303			x		7.2J	S1
	Nickel	3500	x107	1520R	SD-19	2700J	J-B2	500J	S2
	Selenium			4.1	SD-14	9.45J	D-B1	5.1J	S2
	Vanadium	150	x115	48	SD-19	60J	F-B2	41J	S3
	Zinc	71000	x115	11900	SD-19	43000	F-B1	25000	S2

NOTES

Pentachlorophenol is also analyzed as an SVOC.  
blank = no information, may not have been analyzed  
nd(%) = analyzed and not detected at detection limit of #  
x = not analyzed  
J = present, concentration estimated, typically because below contract required detection limit  
.. [J] gives number of detections in 10 samples collected over depth at an SW- station  
Y = Yes, release occurred from Site to ground water  
N = No release to ground water, based on lack of detection in sediment samples  
B = Release ambiguous because present in background at similar concentrations  
?? = Release ambiguous because detected in sediment at less than 10x detection limit of uncontaminated background samples

TABLE 3.10 Background Soil Metal Concentrations

	SS-44 mg/kg	SS-45 mg/kg	GB-29 mg/kg	GB-34 mg/kg	GB-68 mg/kg	HB-20 mg/kg	IB-44 mg/kg	LB-01 mg/kg	NB-07 mg/kg	EE-04-0-0.5 mg/kg	EE-04-3-6 mg/kg	EE-20-0-0.5 mg/kg	EE-20-3-6 mg/kg	EEQ-108-0-0.5 mg/kg	EEQ-108-3-6 mg/kg	Maximum mg/kg
				E&E (May 1988, Appendix D)						USACE (2001, Tables A-4.7, A-4.8)						
Metals																
Chromium	11R*	13	13	13	11	15	12	nd	13	25	13	17	16	17	16	25
Lead	80*	68*	60R	51*	57*	44R	nd	43*	70*	78	8.5	180	180	24	45	180
Mercury	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.083J	0.02J	0.14J	0.0041J	0.044J	0.06J	0.14J
Molybdenum	x	x	x	x	x	x	x	x	x	0.85J	0.5J	1.4J	1.5J	0.72J	0.62J	1.5J
Nickel	15*	16	17	19	14	17	15	14	18	28	18	21	20	15	20	28
Selenium	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd(1.2)	nd(1.1)	nd(1.1)	nd(1.1)	nd(1.2)	nd(1.1)	nd
Vanadium	19	22	36	20	16	27	69	22	21	44	25	31	31	28	31	69
Zinc	170	162	167	190	168*	153	203	170	102	320J	42J	820J	770J	82J	150J	820J

## NOTES

R = Spike sample recovery not within control limits

\* = Duplicate analysis not within control limits

**APPENDIX A: Resume of Gary R. Chirlin**



*Chirlin & Associates, Inc.*

*Rockville, MD 20855  
301-963-6000*

**GARY R. CHIRLIN**

**PROFESSIONAL HISTORY**

Chirlin & Associates, Inc., President, 1986 to present  
Woodward-Clyde Consultants, Inc., Senior Project Engineer, 1984 to 1986  
S.S. Papadopoulos & Associates, Inc., Hydrologist, 1982-1984  
R.W. Cleary, Consulting Hydrogeology, Hydrologist, 1977-1978 (part-time)  
Smithsonian Institution, Chesapeake Bay Center for Environmental Studies,  
Research Hydrologist, 1974-1977

**EDUCATION**

Ph.D. 1982 (Civil Engineering, Water Resources) Princeton University  
S.M. 1974 (Civil Engineering, Water Resources)  
Massachusetts Institute of Technology  
S.B. 1972 (Earth and Planetary Sciences II)  
Massachusetts Institute of Technology

**REGISTRATION AND AFFILIATIONS**

Registered Professional Engineer (MD #13971)  
American Geophysical Union, Hydrology Section  
National Ground Water Association,  
Association of Groundwater Scientists and Engineers  
Technical reviewer: Water Resources Research, J. of  
Hydrology; ASCE J. Hydraulics Div.  
State Water Quality Advisory Committee (Maryland), retired

**TECHNICAL SPECIALTIES**

Quantitative methods in ground-water hydrology;  
contaminant fate and transport in ground water;  
statistical analysis; project management;  
expert testimony

Gary R. Chirlin

## DESCRIPTION OF ACCOMPLISHMENTS

Dr. Chirlin is a civil engineer and hydrologist specializing in the design and analysis of ground water supplies, ground-water contaminant transport, and ground water remedial systems, and in the hydrogeologic aspects of landfill siting and design.

Dr. Chirlin trained in surface- and ground-water hydrology, aquatic chemistry, geology, applied mathematics, statistics, stochastic processes (e.g., kriging), systems analysis, and computer sciences. This mix of subjects has proven to be critical in the analysis of surface-water and ground-water processes.

At the Smithsonian Institution's Chesapeake Bay Center for Environmental Studies, Gary played two roles. As a research hydrologist with Dr. David Correll he studied the relationship between watershed land use ("nonpoint sources") and the water quality of the Rhode River estuary. In addition he designed, installed, and supervised the first onsite computer facility to serve the research staff of CBCES.

After receiving his Ph.D. Gary entered consulting, serving in increasingly responsible technical capacities at two nationally respected firms. He provided mathematical and computer modeling of ground water flow and contaminant transport, design and analysis of aquifer tests, interpretation of hydraulic and water quality field data, design of ground-water remediation facilities, critical technical review, staff training, and project management. At Woodward-Clyde Consultants he was utilized as a "regional resource": for major projects he provided in-house consulting services to Woodward-Clyde offices throughout the eastern and central US.

In 1986 Dr. Chirlin established his own firm. Through CAI he has since served a broad spectrum of clients, from basic research foundations to government/industrial/commercial entities to citizens' groups. His work is very thorough and meticulous in a field where attention to detail often makes the difference between success and failure. He writes and speaks often and well, and recognizes the prevailing importance of communication.

## REFERENCES

Upon request.

Gary R. Chirlin

## **REPRESENTATIVE PROJECT EXPERIENCE**

### **Ground-Water Quality**

#### **Citizens' Watch for a Clean Environment, Chemtronics Superfund site, Swannanoa NC:**

Technical Advisor under TAG. Review and comment on technical documents concerning CERCLA site contaminated by ordinance manufacturing wastes, conduct public informational meetings, and serve as an advocate to EPA on scientific matters.

#### **US Dept. of Justice, Environmental Enforcement Section, Expert Witness, Moyer Municipal Landfill, Collegeville, PA:**

Evaluation of extent and nature of site leachate and ground-water contamination. Establishment of appropriate site background concentrations for naturally occurring substances in soils and ground waters. Extensive review of sampling documentation leading to discovery of switched sample results.

#### **US Dept. of Justice, Environmental Enforcement Section, Expert Witness, Aerojet General Corp. site, CA:**

Evaluation of present and potential rate of TCE migration in ground water to the American River upstream of major public water supplies for Sacramento, CA; in support of CERCLA consent decree negotiations.

#### **US Department of Justice, Environmental Enforcement Section, Expert Witness, Conrail Elkhart Railyard site, IN:**

Determination of origin, extent, and rate of migration of a CCl<sub>4</sub> plume and a TCE plume at the railyard. Geologic data interpretation using domestic well logs, revealing a large body of clay and thus explaining observed contaminant distribution and flow directions and invalidating other experts' opinions. Critical assessment of lead-stem auger (LSA) sampling protocols, thus explaining "inconsistent" spatial patterns of CCl<sub>4</sub> contamination and resolving the onsite origin and limits of that plume.

#### **US Department of Justice, Environmental Enforcement Section, Expert Witness, Borden Chemicals Corp., Geismar, LA:**

Evaluation of the horizontal and vertical extent of DNAPL (especially 12DCA) and dissolved solvents at a large chemical production facility with numerous unlined disposal ponds and channels. Site is underlain by silts and fractured clays. Interpretation of cone penetrometer test (CPT) sampling data and critical assessments of 3D kriging and of a proposed hydraulic containment system.

#### **US Department of Justice, Environmental Enforcement Section, Expert Witness, Aberdeen Pesticide Dumps, NC:**

Determination of hazardous substances released at two disposal areas, extent of migration of these substances in ground water, and divisibility of harm between the sources.

Gary R. Chirlin

**IBM Corp. Solvent Spills, Manassas, VA:**

Hydrologic Investigation to design Remedial Investigation Work Plan for PCE contamination in fractured rock. Technical review of prior investigations. Design of pump tests. Supervision of community well survey program. Work proceeded formally under RCRA but also satisfied CERCLA guidelines and formats.

**Citizens' Recycling Advisory Board and NYC Department of Sanitation, Fresh Kills Landfill, Staten Island NY:**

Technical Review of site investigation and remedial planning for New York City's landfill. The landfill is leaking leachate into the Arthur Kill and tributaries, and into neighboring aquifers.

**Panasote Rubber Bonding Plant, VA, Solvents Contamination:**

Analysis of ground water flow and contaminant discharge from used-solvents and off-spec parts disposal areas toward adjacent properties and river; in anticipation of property transfer.

**Allied Chemical Corp., Baltimore, MD, Chrome Tailings Landfill:**

Assessment of chrome leachate distribution, ground-water flow, and potential leachate migration, in support of RCRA Part B permit application.

**AT&T, Inc., Kearny NJ Works, Solvent Spill:**

Design, supervision, and interpretation of field investigation at retired wire manufacturing facility with volatile organic compounds in the ground water. Conceptual design of remedial ground water extraction/recharge system.

**IT Corp., Livingston, LA Train Derailment:**

Substantive review and revision of statistically-based analytical mass transport model to predict migration of PCE from the derailment site. Technical lead in multidisciplinary planning meetings. A RCRA site.

**Diamond Shamrock Corp., Newark NJ Plant Decommissioning:**

Analysis of alternative remedial designs for site contaminated by dioxin and multiple organic and heavy metal compounds. Slurry wall hydraulics under tidal influence; dewatering during excavation.

**Legal Counsel for IBM Corp., Kansas City, KS, Conservation Chemical Corp. Landfill:** Analysis of hydrogeological aspects of CERCLA site assessment and remedial design for site contaminated by multiple organic and inorganic compounds. Aquifer tests, natural ground-water flow and slurry wall containment dynamics in the Missouri River floodplain; contaminant flux estimates; technical reviews in support of litigation; expert witness testimony.

Gary R. Chirlin

**Legal Counsel for Purex Corp., Garden City, NY, Solvent Transfer Facility:**

Analysis of complex hydrogeological setting and movement of volatile organic solvents in the ground water, using a three-dimensional numerical model. Review of remedial plans; support in settlement negotiations.

**Battelle, Office of Crystalline Repository Development:**

Guidance and review of screening model development for candidate sites of a high-level waste repository in crystalline rock.

**Amoco Oil Company, Independence, MO, Refinery Decommissioning:**

Study design, supervision, and data analysis for Refinery-Wide Hydrology and Groundwater Investigation. Multiple RCRA waste management units onsite required assessment, closure.

**Legal Counsel for Ryan, Elliott and Company, Inc., Real Estate, Boston, MA, Site Assessment prior to Refinancing:**

Inspection and field investigation of multi-use commercial/industrial rental property to assess possible environmental liabilities. Report to title insurance company.

**Union Camp Corporation, Franklin, VA, Lime Mud Pond:**

Field investigation and analysis of hydrogeological conditions in vicinity of high-pH waste containment pond, in support of RCRA Part B permitting of the facility.

**Montgomery County, MD, Travilah Quarry Hydrology:**

Site assessment of suitability of existing quarry as a bale-fill (landfill accepting compressed, baled wastes). Supervision of water-balance field investigation and interpretation. Design flow for treatment facility.

**KLNB Management Company, Columbia, MD, Fuel Oil Tank Leak:**

Hydrologic assessment of oil migration. Design, construction, and operation of oil recovery system. Site assessment, preparation of corrective action plan (CAP) and associated permit applications, NPDES permit application, conceptual and final design, supervision, and startup of total fluids extraction and treatment system. Over 10,000 gallons of fuel oil escaped into the saprolite and shallow bedrock setting.

**Cafritz Corp., Real Estate, Washington DC, Environmental Risk Assessment:**

Assessment of potential liabilities assumed in purchase of a NY shopping mall with existing ground-water contamination.

**Koppers Company, Carbondale, IL, Wood-Preservative Facility:**

Evaluation of ground-water flow beneath site of historical creosote releases. Estimation of aquifer parameters using observed water levels and optimization procedures.

Gary R. Chirlin

**Legal Counsel for Velsicol Corp., Hardeman County, TN:**

Data analysis and development of ground-water models to reconstruct timing of past pesticide releases; in support of litigation.

**Montgomery County, MD, Oaks Sanitary Landfill:**

Performance and analysis of aquifer tests to evaluate two-aquifer system underlying landfill site. Design of a statistical "early-warning" ground water monitoring system to interpret water quality data.

**United Nuclear Corp., Wyoming:**

Development of an optimizing routine to estimate aquifer parameters from the results of pump tests involving multiple, interfering, variable-rate pumping wells and numerous observation wells.

**Citizen's Group, Darnestown School, MD, Leaching Field:**

Evaluation of the effects on local ground-water levels of a proposed sewage leaching field associated with a new development, using numerical modeling. The results of the study led to relocation of the development.

**Water Supply and Water Rights**

**Montville Township, NJ, Water Supply:**

*Numerical model simulation of water supply development impacts in a glacial outwash aquifer.*

**New Mexico State Engineers Office, Water Rights Study:**

Technical review of petitioner's claim on ground- and surface water rights in NM. Assessment of impact of ground-water withdrawals on stream flow using a quasi-3D numerical model of flow. Litigation support.

**New Mexico State Engineers Office, Interstate Ground Water Transfer:**

Numerical modeling to evaluate ground- and surface-water impact of proposed ground water withdrawals from Rio Grande's Mesilla Valley to supply El Paso, TX.

**Tetra Tech, Intl., Salalah Plain, Oman, Salinity Intrusion:**

Numerical modeling of saline wedge encroachment for various ground-water development management options.

**Electric Utility, Western U.S., Water Rights Acquisition:**

Feasibility study of ground water supply for conventional utility plant. Estimation of local streamflow reductions, and identification of required water rights purchases.

**Town of Washington Grove, MD, Spring and Pond Hydrology:**

Assess threat of proposed development to natural spring and ground water flow supplying the town recreational lake.

Gary R. Chirlin

**New Windsor Community Action Project, Carroll County, MD, Quarry Permits  
Review:**

Provide technical guidance and testimony during development of state surface mining, ground water appropriation, and surface discharge permits, and county zoning permit for a proposed marble quarry.

**Electric Power Research Institute, Palo Alto, CA:**

Develop a numerical model of the slug test, derive type curves for partial penetration, and assess limitations of the widely used Hvorslev (1951) and Cooper et al (1967) models.

**Appendix D. Compensation of Gary R. Chirlin**



Compensation of Gary R. Chirlin for this project is on a time and materials basis through Chirlin & Associates, Inc., Rockville, MD. The hourly billing rate for Dr. Chirlin is \$165.00.

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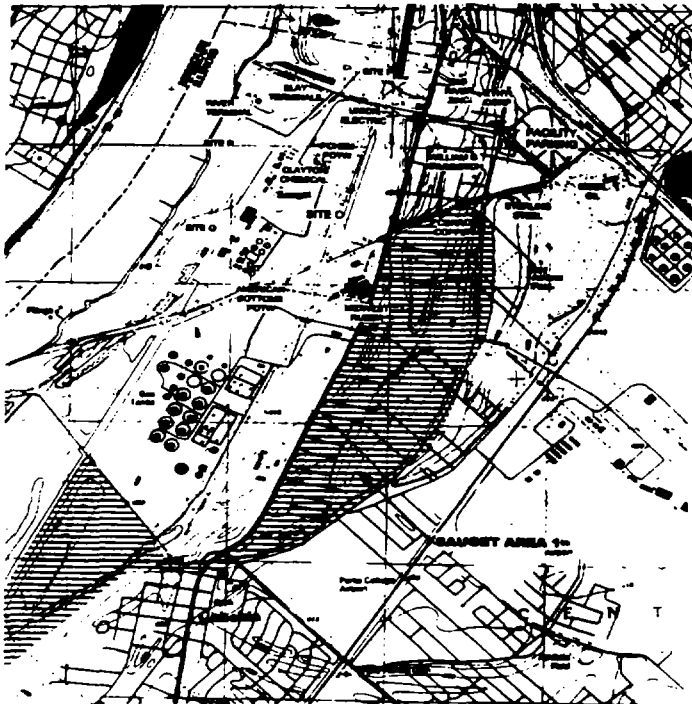
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**ENGINEERING EVALUATION/COST ANALYSIS  
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

**SAUGET AREA 1  
SAUGET AND CAHOKIA, ILLINOIS**

*Revision 0 March 9, 2001*

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*Prepared for:*



**Solutia Inc.**

*Prepared by:*



**ROUX ASSOCIATES, INC.**  
*Environmental Consulting & Management*



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March 9, 2001

Mr. Michael McAteer (3 copies)  
U. S. EPA - Region 5  
77 West Jackson Boulevard (SR-6J)  
Chicago, Illinois 60604-3590

**Re: Sauget Sites Area I January 21, 1999 Administrative Order by Consent  
June 25, 1999 Support Sampling Plan as approved by letter dated  
September 9, 1999 ("Order")**

- Draft Engineering Evaluation / Cost Analysis - Remedial Investigation /  
Feasibility Study Report ("Draft EE/CA - RI/FS Report") Submittal**

Dear Mr. McAteer,

Pursuant to Section V. "Order", Paragraph 2.2 "EE/CA Report", and Paragraph 2.3 "RI/FS Report" of the Sauget Sites Area I January 21, 1999 Administrative Order by Consent ("AOC") and the June 25, 1999 Support Sampling Plan ("SSP") as approved by letter dated September 9, 1999, and consistent with Task 4. "EE/CA Report" and Task 5 "RI/FS Report (Groundwater)" of the Scope of Work for Engineering Evaluation/Cost Analysis and Streamlined Remedial Investigation and Feasibility Study ("SOW") attached to the SSP, Solutia Inc. ("Solutia") hereby submits the Draft EE/CA - RI/FS Report for approval by the United States Environmental Protection Agency ("U. S. EPA"). Pursuant to prior agreement between Solutia and U. S. EPA, and for benefits discussed at the time of the Agreement, the Draft EE/CA and RI/FS Reports are being submitted as separate sections within one combined document, with some overlap between some sections. The EE/CA Report is being submitted as originally scheduled - 60 calendar days after submittal of the Data Report. The RI/FS Report is being submitted 30 days ahead of the original schedule of April 9 - which would have represented 90 calendar days after submittal of the Data Report.

Solutia is fully aware that remedy selection is the responsibility of U. S. EPA. However, pursuant to the approved SSP, Paragraph 6 of Volumes 1D and 1E, "EE/CA Work Plan" and "RI/FS Work Plan" respectively, recommendations for the final EE/CA removal alternative selection and the final RI/FS remedial alternative selection, "...will be included in the Draft EE/CA (and Draft RI/FS) document". Therefore, recommendations for final removal and remedial alternative selections have been respectfully included. Inclusion should also serve to facilitate final removal and remedial alternative selection by the Agency by providing a comprehensive application of Solutia's interpretation of the EE/CA - RI/FS results in relation to CERCLA evaluation criteria. Solutia is also aware that the additional CERCLA evaluation criteria of State and Community acceptance will be considered by U. S. EPA as it exercises its responsibility for selection of the final EE/CA removal action and final RI/FS remedial action.

Delivery of the Draft Sauget Area I EE/CA - RI/FS Report within the AOC mandated schedule has been challenging. Solutia appreciates U. S. EPA's professional and open communications and rapid and fair resolution of issues arising throughout the process. We look forward to a continuation of timely progress toward a final approved EE/CA - RI/FS Report and completion of all obligations pursuant to the AOC.

Sincerely,



D. M. Light  
Manager, Remedial Projects  
Solutia Inc.

cc: (w/enclosure)

Candy Morin - Illinois Environmental Protection Agency  
Kevin de la Bruere - U.S. Fish and Wildlife Service  
Mike Henry - Illinois Department of Natural Resources  
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Thomas Martin - U.S. EPA  
Linda Tape - Thompson Coburn

**ENGINEERING EVALUATION/COST ANALYSIS  
REMEDIAL INVESTIGATION/FEASIBILITY STUDY  
SAUGET AREA 1  
SAUGET AND CAHOKIA, ILLINOIS**

**March 9, 2001**

*Prepared for:*

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## **EXECUTIVE SUMMARY**

On January 21, 1999, Monsanto Company and Solutia Inc. entered into an Administrative Order by Consent (AOC) with Region V of the United States Environmental Protection Agency (USEPA) to develop and implement a Support Sampling Plan (SSP) for Sauget Area 1 which the USEPA refers to as the Site. For clarity purposes, all documents submitted under this AOC used the designations for Sauget Area 1 as set out by the USEPA. This is not an admission by Solutia that it agrees with the USEPA's designation. The Site is located just east of the Mississippi River within the towns of Sauget and Cahokia, Illinois and includes five fill areas (Sites G, H, I, L, and N), one former borrow pit (Site M) and five segments of Dead Creek (CS-B through F). The SSP requires the performance of additional investigative and assessment activities necessary to complete an Engineering Evaluation/Cost Analysis (EE/CA) for affected soils, sediments, surface water and air and a streamlined Remedial Investigation/Feasibility Study (RI/FS) for ground water. This report presents a description and results of the additional investigative and assessment activities completed at the Site as part of the SSP, and evaluates removal and remedial alternatives for addressing potential impacts to human health or the environment. The Site Characterization portion of the EE/CA and the Remedial Investigation are combined and presented in Sections 1.0 through 8.0 of this report. The alternative development and evaluation portion of the EE/CA is presented in Section 9.1 of this report. The FS for ground water is presented in Section 9.2 of this report. The EE/CA and RI/FS comply with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which contains provisions for implementing the requirements of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).

Two Unilateral Administrative Orders (UAOs) involving Sauget Area 1 have also been issued to Solutia by USEPA Region V. The first UAO issued June 21, 1999 requires select culvert replacements along Dead Creek in order to improve hydraulic efficiencies. The second UAO was issued on May 31, 2000, subsequent to the initiation of SSP field activities which commenced in September 1999. The second UAO requires the removal of affected sediments

from Dead Creek Segments CS-B, C, D, E, a portion of F, and Site M, and subsequent placement in a containment cell to be constructed adjacent to CS-B. This removal action will effectively eliminate identified sediment transport and exposure pathways at Dead Creek.

#### **SITE BACKGROUND**

Sauget Area 1 formerly served as a repository for local area wastes dating back prior to the 1920s. Dead Creek received direct and indirect waste and waste-water discharges from local industries and municipalities for over 50 years. Additionally, pits were excavated and used as landfills in areas adjacent to dead Creek for disposal of liquid and solid waste materials. These fill areas were used beginning in the 1930s. In addition, ground water was impacted by industries operating within or adjacent to Area 1. While all of the original sources of waste discharge and disposal in Area 1 have been effectively stopped or controlled, waste deposits remaining in fill areas and Dead Creek sediments represent a secondary source of potential concern to local receptors.

Sites G, H, I, L and N were previously used for disposal of industrial, commercial and municipal solid and liquid waste materials. These fill areas include three closed municipal/industrial landfills (Sites G, H and I), two backfilled former surface impoundments (both comprising Site L) and one backfilled borrow pit that was filled with construction debris (Site N).

The potentially affected portion of Dead Creek has been divided into five segments designated CS-B, C, D, E and F. Creek Segment A is the northernmost (upstream) segment of the Creek and has previously been remediated, filled and covered with crushed gravel. Creek Segment F is located at the southernmost (downstream) end of Area 1, intersects the Borrow Pit Lake and discharges to Old Prairie duPont Creek. Also included in the Creek Study Areas is Site M, a former sand borrow pit located along the eastern side of Creek Segment B and hydraulically connected to Dead Creek.



## **OBJECTIVES AND SCOPE OF WORK**

The overall objective is to characterize affected media in Sauget Area 1 and develop data necessary to support a risk-based remedy selection. Information developed from this process is used to evaluate and select appropriate removal or remedial actions for the Site. The primary investigative and assessment activities completed as part of the SSP included:

- Delineation of source area boundaries;
- Characterization of aquifer parameters;
- Delineation of constituents of potential concern (COPCs) in sediments, soil and ground water;
- Evaluation of the potential presence of COPCs in surface water and air;
- Performance of pilot treatability studies;
- Completion of Human Health and Ecological Risk Assessments; and
- Preparation of EE/CA (soil, sediment, surface water, air) and RI/FS (ground water).

## **SOURCE, NATURE AND EXTENT OF COPCs**

A Conceptual Site Model was developed as part of the SSP to identify preliminary COPCs and significant transport and exposure pathways. Investigations performed as part of the SSP focused on delineating the source, nature and extent of COPCs in source areas, sediments, surface water, floodplain and source area soils, ground water and air. Major findings of these investigations were:

- No significant sources requiring removal were identified at Sites G, H, I, L or N.
- Waste materials present in Site G, H, I, L and N do not serve as a significant ongoing source of impact to ground water.
- Dense non-aqueous phase liquids (DNAPLs) may be trapped in the alluvial aquifer matrix underlying and downgradient of Sites G and I, but are widely dispersed as small blobs and ganglia and essentially immobile due to capillary forces. Some DNAPL may have pooled on the bedrock surface beneath Sites G and I. Slow dissolution of DNAPLs represent the primary ongoing source of ground-water contamination.

- COPCs present in ground water underlying Area 1 should attenuate to below action levels prior to reaching the Mississippi River.
- The sediment removal actions to be completed under the UAO will effectively eliminate significant sediment transport and exposure pathways.
- Air and surface water do not represent significant transport or exposure pathways.

## **HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS**

A baseline Human Health Risk Assessment and Short-Term Risk Assessment were performed by ENSR International. A Baseline Ecological Risk Assessment was performed by Menzie-Cura & Associates, Inc. In both cases, Creek Segments B, C, D, E and the upper portion of F, as well as Site M, were excluded from the assessments given that these sources are to be eliminated via the sediment removal action to be performed in accordance with the UAO. The results of the Human Health Risk Assessment and Short-Term Risk Assessment recommend removal action be considered for a single surface soil sample location at Site I based on PCB and dioxin concentrations detected at that location. In addition, this assessment concluded that any future excavation work at Sites G and H should be monitored to determine appropriate personal protective equipment requirements due to potential inhalation exposures to benzene, chloroform or naphthalene volatilizing from exposed ground water. No unacceptable risks were identified for sediments, floodplain soils, surface water or air. The results of the Ecological Risk Assessment indicate no risks requiring removal action based on a weight of evidence approach and comparison to two reference areas.

## **REMOVAL ACTION AND REMEDIAL ACTION OBJECTIVES**

Based on the findings and conclusions of the RI and Site Characterization investigations and risk assessments performed at the Site, the following Removal Action and Remedial Action Objectives were established:

- Provide institutional controls to require appropriate protection of construction and industrial workers in fill areas.

- Establish engineering controls (e.g., fences and caps) for fill areas to prevent erosion of surface soils and potential for direct contact exposure, and to mitigate potential for rainfall infiltration to generate leachate where waste is present in leachable quantities.
- Maintain existing institutional controls to preclude the use of ground water as a potable water source in Area 1.
- Mitigate the potential for ground water with contaminant concentrations in excess of appropriate standards to discharge from Area 1.

#### **EE/CA – FILL AREAS**

The fill areas are the only areas requiring evaluation of potential remedies under the EE/CA process, based on the results of fate and transport analysis, the Human Health Risk Assessment and the Ecological Risk Assessment. Five removal alternatives were considered and evaluated against the criteria of effectiveness, implementability and cost. Two alternatives that met the evaluation criteria and satisfied the remedial action objectives for fill areas are as follows:

Fill Area Alternative D	Fill Area Alternative E
<ul style="list-style-type: none"><li>• Institutional Controls</li><li>• Ground-Water Monitoring</li><li>• DNAPL Recovery, Sites G and I</li><li>• Protective Cover, Sites G, H and L</li><li>• Low Permeability Asphalt Cover, Site I</li></ul>	<ul style="list-style-type: none"><li>• Institutional Controls</li><li>• Ground-Water Monitoring</li><li>• DNAPL Recovery, Sites G and I</li><li>• Low Permeability Cover, Sites G, H and L</li><li>• Low Permeability Asphalt Cover, Site I</li></ul>

The present value cost of Alternative D is \$9,820,306 compared to a present value cost of \$10,307,777 for Alternative E. Alternative D is the recommended alternative.

#### **FS – GROUND WATER**

Ground water is addressed in the context of the streamlined FS process. Four remedial alternatives were considered and evaluated against the criteria of overall protection of human health and the environment, compliance with applicable or relevant and appropriate

requirements, long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability, and cost. Three alternatives met the evaluation criteria and satisfied the remedial action objectives. These are summarized in the following table:

Ground Water Alternative B	Ground Water Alternative C	Ground Water Alternative D
<ul style="list-style-type: none"><li>• Institutional Controls</li><li>• Ground-Water Monitoring</li></ul>	<ul style="list-style-type: none"><li>• Institutional Controls</li><li>• Ground-Water Monitoring</li><li>• Hydraulic Containment</li><li>• Ground-Water Treatment</li></ul>	<ul style="list-style-type: none"><li>• Institutional Controls</li><li>• Ground-Water Monitoring</li><li>• Plume Recovery</li><li>• Ground-Water Treatment</li></ul>

The present value cost of Alternative B is \$2,818,759. The present value cost for Alternatives C and D are \$13,414,593 and \$27,161,595, respectively. The detailed analysis demonstrates that the primary source of ongoing ground-water contamination is slow dissolution of widely dispersed, immobile DNAPL. The analysis concludes that ground-water restoration is impracticable. Restoration of ground water downgradient of Site I will take hundreds of years, and active pumping does not appreciably accelerate the time required when compared to natural restoration.

Ground-water modeling was performed to evaluate plume and source behavior. The modeling concludes that the ground-water contaminant plumes are either stable or less than 50 feet from their ultimate plume lengths, and that no plume with contaminant concentrations in excess of appropriate standards should reach the Mississippi River. The modeling also concludes that the mass removal rate due to ongoing, natural processes is such that more than 11,000 pounds per year of contaminant mass are removed before the plume downgradient of Site I reaches Route 3, the downgradient Site boundary. However, considering the NCP preference for prevention of further plume migration when ground-water restoration is impracticable, Alternative C, which includes a fenceline hydraulic containment system, is the recommended alternative for ground water.

## CONTENTS

<b>EXECUTIVE SUMMARY</b>	i
<b>TABLE OF CONTENTS</b>	vii
<b>1.0 INTRODUCTION</b>	1-1
1.1 General	1-1
1.2 Objectives	1-3
1.2.1 Support Sampling Plan Objectives	1-3
1.2.2 EE/CA Objectives	1-6
1.2.3 RI/FS Objectives	1-6
1.3 Technical Approach	1-7
1.4 Report Organization	1-10
<b>2.0 BACKGROUND</b>	2-1
2.1 Environmental Setting	2-1
2.1.1 Site Location and Description	2-1
2.1.2 Climate	2-7
2.1.3 Physiography and Topography	2-7
2.1.4 Drainage and Hydrology	2-8
2.1.5 Hydrogeology	2-9
2.1.5.1 Regional Hydrogeology	2-9
2.1.5.2 Site Hydrogeology	2-12
2.1.6 Surrounding Land Use and Population	2-13
2.2 Waste Disposal	2-26
2.2.1 Liquid and Solid Waste Disposal	2-26
2.2.2 Waste Water Disposal	2-28
2.3 Removal and Remedial Actions	2-34
2.3.1 Creek Segment A Remedial Action	2-34
2.3.2 Creek Segment B Removal Action	2-35
2.3.3 Site G Removal Action	2-35
2.3.4 Dead Creek Culvert Replacement Removal Action	2-35
2.3.5 CS-B, C, D, E, and F Sediment Removal Action	2-36
<b>3.0 SUPPLEMENTAL SAMPLING PLAN INVESTIGATION DESCRIPTION</b>	3-1
3.1 Field Investigation Summary and Approach	3-1
3.2 Fill Area Investigation	3-4
3.2.1 Soil Gas Survey	3-4
3.2.2 Waste Sampling	3-5

3.2.3	Magnetometer Survey -----	3-6
3.2.4	Buried Drum and Tank Identification -----	3-7
3.3	Ground-Water Investigation -----	3-8
3.3.1	Ground-Water Sampling -----	3-8
3.3.1.1	Fill Area Ground-Water Sampling -----	3-8
3.3.1.2	Alluvial Aquifer Sampling -----	3-10
3.3.1.3	Downgradient Alluvial Aquifer Sampling -----	3-11
3.3.1.4	Alluvial Aquifer/Bedrock Interface Sampling -----	3-12
3.3.1.5	Domestic Well Sampling -----	3-13
3.3.1.6	Shallow Residential Area Ground-Water Sampling ---	3-14
3.3.1.7	Time-Series Sampling -----	3-14
3.3.1.8	Upgradient Ground-Water Sampling -----	3-15
3.3.2	Ground-Water Flow Direction -----	3-16
3.3.3	Aquifer Testing -----	3-16
3.4	Soil Investigation -----	3-16
3.4.1	Undeveloped Area Soil Sampling -----	3-17
3.4.2	Developed Area Soil Sampling -----	3-18
3.4.3	Background Soil Sampling -----	3-19
3.4.4	Grain Size Analysis -----	3-19
3.5	Sediment Sampling Investigation -----	3-19
3.5.1	Industry-Specific Sediment Sampling -----	3-20
3.5.1.1	Undeveloped Creek Segments (CS-B and CS-F) -----	3-20
3.5.1.2	Developed Creek Segments (CS-C, CS-D, & CS-E) -	3-21
3.5.1.3	Borrow Lake Pit -----	3-21
3.5.2	Broad Scan Sediment Sampling -----	3-22
3.5.2.1	Dead Creek Segments, Borrow Pit Lake and Reference Areas -----	3-23
3.5.2.2	Site M -----	3-24
3.5.2.3	Old Prairie duPont Creek -----	3-24
3.6	Surface-Water Investigation -----	3-25
3.7	Air Sampling -----	3-26
3.8	Ecological Risk Assessment -----	3-27
3.9	Treatability Pilot Studies -----	3-27
4.0	<b>SUPPORT SAMPLING PLAN INVESTIGATION RESULTS -----</b>	<b>4-1</b>
4.1	Fill Area Investigation Results -----	4-2
4.1.1	Fill Area Boundary Survey (Boundary Confirmation Trenches) --	4-2
4.1.2	Soil Gas Survey -----	4-3
4.1.3	Waste Sampling -----	4-3
4.1.3.1	Discrete Surface Sampling Analyses -----	4-3
4.1.3.2	Waste Subsurface Composite Sample Analyses -----	4-4
4.1.4	Buried Drum and Tank Identification Results -----	4-4
4.2	Ground-Water Investigation Results -----	4-5
4.2.1	Fill Area Ground-Water Sampling -----	4-7

4.2.2	Alluvial Aquifer Sampling	4-7
4.2.3	Downgradient Alluvial Aquifer Sampling	4-8
4.2.4	Upgradient Sampling	4-9
4.2.5	Shallow Residential Area, Time-Series and Domestic Ground-Water Sampling	4-9
4.2.6	Ground-Water Flow Direction and Slug Tests	4-10
4.3	Soil Investigation Results	4-10
4.3.1	Undeveloped Area Soil Sampling	4-11
4.3.2	Developed Area Soil Sampling	4-12
4.3.3	Background Soil Sampling	4-12
4.4	Creek Segment Investigation Results	4-12
4.4.1	Creek Segment Investigation (Industry-Specific Constituents)	4-13
4.4.1.1	Undeveloped Area Creek Sediments (CS-B and CS-F)	4-13
4.4.1.2	Developed Area Creek Sediments (CS-C, CS-D and CS-E)	4-14
4.4.1.3	Borrow Pit Lake	4-14
4.4.2	Creek Segment Investigation Results (Broad-Scan Constituents)	4-15
4.4.2.1	Dead Creek Sediments, Borrow Pit Lake, and Reference Areas	4-15
4.4.2.2	Site M and Old Prairie du Pont Creek	4-15
4.5	Surface-Water Investigation Results	4-16
4-6	Air Investigation Results	4-16
4-7	Ecological Risk Assessment	4-17
4-8	Treatability Study Results	4-17
5.0	SOURCE, NATURE AND EXTENT OF CONTAMINATION	5-1
5.1	General	5-1
5.2	Fill Study Area	5-2
5.2.1	Fill Area Waste Volumes	5-3
5.2.2	Fill Area Waste Characterization and Leaching Potential	5-4
5.2.3	Ground Water	5-9
5.2.3.1	Site G and Downgradient Alluvial Aquifer	5-13
5.2.3.2	Site G and Southwest Transect Alluvial Aquifer	5-17
5.2.3.3	Sites G and H Alluvial Aquifer/Bedrock Interface	5-18
5.2.3.4	Site G and Upgradient Alluvial Aquifer	5-21
5.2.3.5	Site I and Downgradient Alluvial Aquifer	5-22
5.2.3.6	Site I and Alluvial Aquifer/Bedrock Interface	5-27
5.2.3.7	Site I and Upgradient Alluvial Aquifer	5-29
5.2.4	Surface Soil	5-30
5.2.5	Air	5-32
5.3	Dead Creek Study Area	5-33
5.3.1	Downstream Creek Sediments	5-34

5.3.2	Floodplain Soils .....	5-35
5.3.3	Surface Water .....	5-40
5.3.4	Residential Ground Water.....	5-41
 <b>6.0 HUMAN HEALTH RISK ASSESSMENT .....</b>		<b>6-1</b>
 <b>7.0 ECOLOGICAL RISK ASSESSMENT .....</b>		<b>7-1</b>
 <b>8.0 FINDINGS AND CONCLUSIONS .....</b>		<b>8-1</b>
 <b>9.0 ENGINEERING EVALUATION/ COST ANALYSIS AND FEASIBILITY STUDY .....</b>		<b>9-1</b>
9.1	Fill Areas .....	9-1
9.1.1	Identification and Screening of Technologies .....	9-3
9.1.1.1	Removal Action Objectives .....	9-3
9.1.1.2	General Response Actions .....	9-5
9.1.1.2.1	No Action .....	9-6
9.1.1.2.2	Institutional Controls .....	9-6
9.1.1.2.3	Containment .....	9-7
9.1.1.3	Applicable or Relevant and Appropriate Requirements .....	9-7
9.1.1.4	Identification and Screening of Technology Types And Process Options .....	9-9
9.1.1.4.1	Institutional Controls .....	9-9
9.1.1.4.2	Containment .....	9-11
9.1.2	Detailed Analysis of Alternatives .....	9-14
9.1.2.1	Fill Area Alternative A .....	9-15
9.1.2.1.1	Effectiveness .....	9-15
9.1.2.2	Fill Area Alternative B .....	9-15
9.1.2.2.1	Effectiveness .....	9-16
9.1.2.3	Fill Area Alternative C .....	9-17
9.1.2.3.1	Effectiveness .....	9-17
9.1.2.4	Fill Area Alternative D .....	9-18
9.1.2.4.1	Effectiveness .....	9-20
9.1.2.4.2	Implementability .....	9-21
9.1.2.4.3	Cost .....	9-21
9.1.2.5	Fill Area Alternative E .....	9-22
9.1.2.5.1	Effectiveness .....	9-22
9.1.2.5.2	Implementability .....	9-23
9.1.2.5.3	Cost .....	9-23
9.1.3	Comparative Analysis .....	9-24
9.1.3.1	Effectiveness .....	9-24
9.1.3.2	Implementability .....	9-25
9.1.3.3	Cost .....	9-25



9.1.4	Recommended Alternative .....	9-25
9.2	Ground Water .....	9-25
9.2.1	Identification and Screening of Technologies .....	9-27
9.2.1.1	Remedial Action Objectives .....	9-27
9.2.1.2	General Response Actions .....	9-28
9.2.1.2.1	No Action .....	9-28
9.2.1.2.2	Institutional Controls .....	9-29
9.2.1.2.3	Ground-Water Monitoring .....	9-29
9.2.1.2.4	Engineered Barriers .....	9-29
9.2.1.3	Applicable or Relevant and Appropriate Requirements .....	9-30
9.2.1.4	Identification and Screening of Alternatives .....	9-33
9.2.1.4.1	Institutional Controls .....	9-33
9.2.1.4.2	Ground-Water Monitoring .....	9-34
9.2.1.4.3	Engineered Barriers .....	9-35
9.2.2	Detailed Analysis of Alternatives .....	9-36
9.2.2.1	Ground Water Alternative A .....	9-37
9.2.2.1.1	Overall Protection of Human Health and the Environment .....	9-37
9.2.2.2	Ground Water Alternative B .....	9-37
9.2.2.2.1	Overall Protection of Human Health and the Environment .....	9-39
9.2.2.2.2	Compliance with ARARs .....	9-39
9.2.2.2.3	Long-Term Effectiveness and Permanence .....	9-39
9.2.2.2.4	Reduction of Toxicity, Mobility or Volume .....	9-40
9.2.2.2.5	Short-Term Effectiveness .....	9-40
9.2.2.2.6	Implementability .....	9-40
9.2.2.2.7	Cost .....	9-41
9.2.2.3	Ground Water Alternative C .....	9-41
9.2.2.3.1	Overall Protection of Human Health and the Environment .....	9-42
9.2.2.3.2	Compliance with ARARs .....	9-43
9.2.2.3.3	Long-Term Effectiveness and Permanence .....	9-43
9.2.2.3.4	Reduction of Toxicity, Mobility or Volume .....	9-44
9.2.2.3.5	Short-Term Effectiveness .....	9-44
9.2.2.3.6	Implementability .....	9-45
9.2.2.3.7	Cost .....	9-45
9.2.2.4	Ground Water Alternative D .....	9-46
9.2.2.4.1	Overall Protection of Human Health and the Environment .....	9-47

9.2.2.4.2	Compliance with ARARs -----	9-47
9.2.2.4.3	Long-Term Effectiveness and Permanence -----	9-48
9.2.2.4.4	Reduction of Toxicity, Mobility or Volume -----	9-48
9.2.2.4.5	Short-Term Effectiveness -----	9-49
9.2.2.4.6	Implementability -----	9-49
9.2.2.4.7	Cost -----	9-50
9.2.3	Comparative Analysis -----	9-50
9.2.3.1	Overall Protection of Human Health and the Environment -----	9-52
9.2.3.2	Compliance with ARARs -----	9-52
9.2.3.3	Long-Term Effectiveness and Permanence -----	9-52
9.2.3.4	Reduction of Toxicity, Mobility or Volume through Treatment -----	9-53
9.2.3.5	Short-Term Effectiveness -----	9-53
9.2.3.6	Implementability -----	9-54
9.2.3.7	Cost -----	9-54
9.2.4	Recommended Alternative -----	9-54

## 10.0 REFERENCES

### TABLES

Table 3-1	Samples Collected at Sauget Area 1
Table 4-1	Fill Area Discrete Surface Sample Summary – Site G
Table 4-2	Fill Area Discrete Surface Sample Summary – Site H
Table 4-3	Fill Area Discrete Surface Sample Summary – Site I
Table 4-4	Fill Area Discrete Surface Sample Summary – Site L
Table 4-5	Fill Area Discrete Surface Sample Summary – Site N
Table 4-6	Fill Area Composite Sample Summary – Site G
Table 4-7	Fill Area Composite Sample Summary – Site H
Table 4-8	Fill Area Composite Sample Summary – Site I
Table 4-9	Fill Area Composite Sample Summary – Site L
Table 4-10	Fill Area Composite Sample Summary – Site N
Table 4-11	Ground-Water Sampling Summary – Site I
Table 4-12	Ground-Water Sampling Summary – Sites G, H & L
Table 4-13	Ground-Water Sampling Summary – Residential Areas
Table 4-14	Hydraulic Conductivity Estimates Based on RI/FS Slug Test Data
Table 4-15	Floodplain Soils – Surface Sample Summary
Table 4-16	Floodplain Soils – Subsurface Sample Summary

Table 4-17	Sediment Sampling Summary – Creek Segment B
Table 4-18	Sediment Sampling Summary – Creek Segment F
Table 4-19	Sediment Sampling Summary – Creek Segment C
Table 4-20	Sediment Sampling Summary – Creek Segment D
Table 4-21	Sediment Sampling Summary – Creek Segment E
Table 4-22	Sediment Sampling Summary – Reference Areas
Table 4-23	Sediment Sampling Summary – Site M
Table 4-24	Sediment Sampling Summary – Old Prairie duPont Creek
Table 4-25	Surface-Water Sampling Summary – Creek Segment B
Table 4-26	Surface-Water Sampling Summary – Creek Segment D
Table 4-27	Surface-Water Sampling Summary – Creek Segment E
Table 4-28	Surface-Water Sampling Summary – Creek Segment F
Table 4-29	Surface-Water Sampling Summary – Site M
Table 4-30	Surface-Water Sampling Summary – Old Prairie duPont Creek
Table 4-31	Surface-Water Sampling Summary – Reference Areas
Table 4-32	Air Sampling Summary – Upwind
Table 4-33	Air Sampling Summary – Downwind
Table 9-1	Comparative Analysis of Fill Area Alternatives
Table 9-2	Comparative Analysis of Ground Water Alternatives

## FIGURES

Figure 1-1	Site Location Map
Figure 1-2	Site Boundary Map
Figure 2-1	Generalized Cross Section
Figure 2-2	Surrounding Area Use
Figure 3-1	Test Trenches & Waste Sampling Site G
Figure 3-2	Test Trenches & Waste Sampling Site H
Figure 3-3	Test Trenches & Waste Sampling Site I
Figure 3-4	Test Trenches & Waste Sampling Site L
Figure 3-5	Test Trenches & Waste Sampling Site N
Figure 3-6	Soil Gas Survey Site G
Figure 3-7	Soil Gas Survey Site H
Figure 3-8	Soil Gas Survey Site I
Figure 3-9	Soil Gas Survey Site L
Figure 3-10	Soil Gas Survey Site N
Figure 4-1	Waste Discrete Surface, Total VOCs
Figure 4-2	Waste Discrete Surface, Total SVOCs
Figure 4-3	Waste Discrete Surface, Total PCBs

Figure 4-4	Waste Discrete Surface, Total Pesticides	—
Figure 4-5	Waste Discrete Surface, Total Herbicides	—
Figure 4-6	Waste Discrete Surface, Total PCDD/PCDF TEQs	—
Figure 4-7	Waste Discrete Surface, Copper	—
Figure 4-8	Waste Discrete Surface, Lead	—
Figure 4-9	Waste Discrete Surface, Nickel	—
Figure 4-10	Waste Discrete Surface, Zinc	—
Figure 4-11	Waste Composite Borings, Total TCLP VOCs	—
Figure 4-12	Waste Composite Borings, Total TCLP SVOCs	—
Figure 4-13	Waste Composite Borings, Total PCBs	—
Figure 4-14	Waste Composite Borings, Total TCLP Pesticides	—
Figure 4-15	Waste Composite Borings, Total TCLP Herbicides	—
Figure 4-16	Waste Composite Borings, Total TCLP PCDD/PCDF TEQs	—
Figure 4-17	Waste Composite Borings, Total TCLP Lead	—
Figure 4-18	Ground Water, Total VOCs	—
Figure 4-19	Ground Water, Total SVOCs	—
Figure 4-20	Ground Water, Total PCBs	—
Figure 4-21	Ground Water, Total Pesticides	—
Figure 4-22	Ground Water, Total Herbicides	—
Figure 4-23	Ground Water, PCDD/PCDF TEQs	—
Figure 4-24	Ground Water, Copper	—
Figure 4-25	Ground Water, Lead	—
Figure 4-26	Ground Water, Nickel	—
Figure 4-27	Ground Water, Zinc	—
Figure 4-28	Potentiometric Surface Map of the Shallow Hydrogeologic Unit, Alluvial Aquifer, Fourth Quarter 1999	—
Figure 4-29	Potentiometric Surface Map of the Middle Hydrogeologic Unit, Alluvial Aquifer, Fourth Quarter 1999	—
Figure 4-30	Potentiometric Surface Map of the Deep Hydrogeologic Unit, Alluvial Aquifer, Fourth Quarter 1999	—
Figure 4-31	Potentiometric Surface Map of the Shallow Hydrogeologic Unit, Alluvial Aquifer, Second Quarter 2000	—
Figure 4-32	Potentiometric Surface Map of the Middle Hydrogeologic Unit, Alluvial Aquifer, Second Quarter 2000	—
Figure 4-33	Potentiometric Surface Map of the Deep Hydrogeologic Unit, Alluvial Aquifer, Second Quarter 2000	—
Figure 4-34	Slug Test Locations	—
Figure 4-35	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Total VOCs	—
Figure 4-36	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Total SVOCs	—
Figure 4-37	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Total PCBs	—

Figure 4-38	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Total Pesticides
Figure 4-39	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Total Herbicides
Figure 4-40	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), PCDD/PCDF TEQs
Figure 4-41	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Copper
Figure 4-42	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Lead
Figure 4-43	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Nickel
Figure 4-44	Developed/Undeveloped Areas, Background Surface Soil (0-0.5 ft.), Zinc
Figure 4-45	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total VOCs
Figure 4-46	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total SVOCs
Figure 4-47	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total PCBs
Figure 4-48	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total Pesticides
Figure 4-49	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total Herbicides
Figure 4-50	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Total PCDD/PCDF TEQs
Figure 4-51	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Copper
Figure 4-52	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Lead
Figure 4-53	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Nickel
Figure 4-54	Developed/Undeveloped Areas, Background Sub-Surface Soil (3-6 ft.), Zinc
Figure 4-55	Industry-Specific Sediments, Diesel Range Organics
Figure 4-56	Industry-Specific Sediments, Gasoline Range Organics
Figure 4-57	Industry-Specific Sediments, Copper
Figure 4-58	Industry-Specific Sediments, Zinc
Figure 4-59	Industry-Specific Sediments, Total PCBs
Figure 4-60	Broad-Scan/Ecological Sediments, Total VOCs
Figure 4-61	Broad-Scan/Ecological Sediments, Total SVOCs
Figure 4-62	Broad-Scan/Ecological Sediments, Total PCBs
Figure 4-63	Broad-Scan/Ecological Sediments, Total Pesticides
Figure 4-64	Broad-Scan/Ecological Sediments, Total Herbicides

Figure 4-65	Broad-Scan/Ecological Sediments, PCDD/PCDF TEQs
Figure 4-66	Broad-Scan/Ecological Sediments, Copper
Figure 4-67	Broad-Scan/Ecological Sediments, Lead
Figure 4-68	Broad-Scan/Ecological Sediments, Nickel
Figure 4-69	Broad-Scan/Ecological Sediments, Zinc
Figure 4-70	Surface Water, Total VOCs
Figure 4-71	Surface Water, Total SVOCs
Figure 4-72	Surface Water, Total PCBs
Figure 4-73	Surface Water, Total Pesticides
Figure 4-74	Surface Water, Total Herbicides
Figure 4-75	Surface Water, PCDD/PCDF TEQs
Figure 4-76	Surface Water, Copper
Figure 4-77	Surface Water, Lead
Figure 4-78	Surface Water, Nickel
Figure 4-79	Surface Water, Zinc
Figure 4-80	Air, Total VOCs
Figure 4-81	Air, Total SVOCs
Figure 4-82	Air, Total PCBs
Figure 4-83	Air, PCDD/PCDF TEQs
Figure 4-84	Air, Copper
Figure 4-85	Air, Lead
Figure 4-86	Air, Nickel
Figure 4-87	Air, Zinc
Figure 9-1	Monitoring Well Locations
Figure 9-2	Cover Contours, Sites G, H and L
Figure 9-3	Protective Cover Details, Sites G, H and L
Figure 9-4	Cover Contours, Site I
Figure 9-5	Low Permeability Cover Details, Site I
Figure 9-6	Low Permeability Cover Details, Conceptual Design
Figure 9-7	Low Permeability Cover Details, Site I
Figure 9-8	Low Permeability Cover Details, Sites G, H and L
Figure 9-9	Extraction Well Conceptual Design
Figure 9-10	Extraction Well Locations, Hydraulic Containment
Figure 9-11	Conceptual Design Treatment Train

**PLATES**

**Plate 4-1                      Sediment Sample Locations**

**APPENDICES**

- A.     Treatability Study Progress Report**
- B.     Slug Test Data Analyses**
- C.     Ground-Water Modeling Study – Sauget Area 1**
- D.     Source Evaluation Study – Sauget Area 1**
- E.     Cost Estimate Calculations**







## **1.0 INTRODUCTION**

### **1.1 General**

On January 21, 1999, Monsanto Company and Solutia Inc. (Respondents) entered into an Administrative Order by Consent (AOC) with Region V of the United States Environmental Protection Agency (USEPA) with regards to environmental actions to be completed at Sauget Area 1 in Sauget and Cahokia, Illinois (Site or Area 1). Area 1 is located just east of the Mississippi River within the towns of Sauget and Cahokia, Saint Clair County, Illinois as shown on Figure 1-1. Sauget Area 1 is bounded on the north by the Alton Southern Railroad, on the east by Falling Springs Road, on the south by Route 157, and on the west by Route 3. The Site includes five (5) fill areas near Dead Creek (Creek) known as Sites G, H, I, L, and N. Also included in the Site are five (5) segments of Creek identified as Creek Segments (CS) B through F and one former borrow pit (Site M). The locations of these areas and the perimeter of Sauget Area 1 are illustrated on Figure 1-2.

Area 1 has been subjected to multiple historic industrial discharges, waste disposal and manufacturing activities over an extended period of time. Many of the activities and disposals associated with the industries within or adjacent to Sauget Area 1 are likely to have impacted environmental media. Characterization of sources at industrial facilities and characterization of the extent of migration from these sources through the soil, surface water, sediment, ground water or air pathways was not included in the scope of the AOC. Ground water beneath Area 1 contributes to part of a regional ground-water concern. A second study area is located just west (downgradient) of Sauget Area 1 and is referred to as Sauget Area 2. Facilities located within Sauget Area 2 include land disposal, electrical power generation and transmission, bulk terminal, waste-water treatment, and incineration-related operations. This investigation focuses only on Sauget Area 1, which is separated from Sauget Area 2 by Route 3.

One of the requirements of the AOC, identified in Section V and in the supplemental Scope of Work (SOW), is to prepare and implement an Engineering Evaluation/Cost Analysis (EE/CA) to address the soil, sediments, leachate, surface water and air at the Site. In addition, the

AOC and the SOW require the implementation of a focused Remedial Investigation/Feasibility Study (RI/FS) to address ground water in Area 1. A Support Sampling Plan (SSP) was prepared by Solutia Inc. and approved by the USEPA Region V on September 9, 1999 to implement the actions required by the AOC SOW and provide the data necessary to support completion of both the EE/CA and the RI/FS.

The purpose of the SSP investigation was to provide the data needed to evaluate the impact to soil, sediments, surface water, ground water, and air resulting from the disposal/deposition of materials in Sauget Area 1 and to assess the associated risk to human health and the environment. The EE/CA and the RI/FS were subsequently performed to evaluate remedial alternatives for addressing the impact to human health and/or to the environment from affected media.

The SSP, EE/CA and RI/FS were conducted in a manner consistent with the requirements of the AOC and the SOW. Furthermore, the USEPA *Guidance on Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA540-G-89-004) and *Guidance on Conducting Non-Time Critical Removal Actions Under CERCLA* (EPA540-R-93-057) were used as guidance documents during implementation of these programs. The EE/CA and RI/FS comply with the requirements of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), which contains provisions for implementing the requirements of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERLA). The EE/CA and FS fully utilize the presumptive remedy approach and streamlining principles prescribed by the NCP and the Superfund Accelerated Cleanup Model.

On May 31, 2000, the USEPA issued a Unilateral Administrative Order (UAO) requiring Solutia Inc. to remove sediments from Creek Segments B, C, D, and E, and from Site M. The UAO also requires that these sediments be transferred into an on-Site containment cell. A Time Critical Removal Action Work Plan was submitted to the USEPA on June 30, 2000, and installation of a sediment dewatering system commenced in November 2000. Materials to be

removed in accordance with this UAO have therefore been screened from further consideration under the EE/CA process.

## **1.2 Objectives**

The overall objective of the Site characterization process is to characterize affected media in Area 1 sufficient to support an informed risk management decision regarding remedy selection. Data and information from this process are then used in the EE/CA and FS to evaluate and ultimately recommend the most appropriate remedial actions at the Site. Specific objectives established for the SSP, EE/CA and RI/FS are presented in the subsections below.

### **1.2.1 Support Sampling Plan Objectives**

The objective of the SSP is to further determine the extent of contamination at the Site beyond that defined by previous Site investigations. This plan contains a description of equipment specifications, required analyses, sample types, and sample locations and frequency. The plan addresses specific hydrologic, hydrogeologic and air transport methods including, but not limited to, geologic mapping, geophysics, field screening, drilling and well installation, flow determination, and soil, water, sediment, sludge, and waste sampling to determine the extent of contamination. Data requirements are identified for specific remedial technologies that may be necessary to evaluate remediation alternatives in the EE/CA and the RI/FS. Discrete objectives for individual components of the SSP are presented in the paragraphs that follow.

#### **Waste Characterization Sampling Plan**

Fill area samples were collected in order to characterize the wastes present at each site and to evaluate potential exposures for the Human Health Risk Assessment (HHRA; outdoor industrial worker and construction/utility worker exposure scenarios). The Human Health Risk Assessment Work Plan is included as Volume 1B of the SSP.

### **Ground-Water Sampling Plan**

Ground-water samples were collected in the alluvial aquifer and alluvial aquifer/bedrock interface at the fill areas, in the alluvial aquifer downgradient of the fill areas and in shallow ground-water and domestic wells adjacent to Dead Creek. The purpose of this sampling is to define current ground-water quality conditions at the fill areas, to determine ground-water quality downgradient from the fill areas and to provide information for the HHRA (volatilization from ground water to outdoor air for the outdoor industrial worker and construction/utility worker, vapor intrusion into buildings for the indoor industrial worker, and residential use of ground water from shallow wells for lawn and garden watering scenarios).

### **Soil Sampling Plan**

Soil samples were collected in both undeveloped and developed areas that are susceptible to flooding and deposition of wind-blown dust. Specifically, floodplain soil sampling was conducted in an area bounded by Queeny Road on the north, Falling Springs Road on the east, Route 157 on the south and Route 3 (Mississippi Avenue) on the west. This is the area where water backs up at road crossings during heavy rains and where Site-related constituents were known to be present in Creek sediments. This area also includes most of the residential development in Area 1.

Information from the soil sampling program is used to determine the extent of migration due to overbank flooding and wind-blown dust deposition. In addition, surficial and subsurface soil information is used in the HHRA (outdoor industrial worker, construction/utility worker and residential exposure scenarios) and Ecological Risk Assessment (ERA).

### **Sediment Sampling Plan**

Vertically integrated sediment samples were collected in Dead Creek to determine the extent of downstream migration of Site-related constituents and to provide information for use in the HHRA (recreational teenager and recreational fishing scenarios) and the ERA (potential

ecological receptor exposure to sediments). The Ecological Risk Assessment Work Plan is included as Volume 1C of the SSP.

#### **Surface-Water Sampling Plan**

Surface-water samples were collected to determine the extent of downstream migration of Site-related constituents and to provide information for use in the HHRA (recreational teenager and recreational fishing scenarios) and the ERA (endpoint organism exposure to surface water).

#### **Air Sampling Plan**

Ambient air sampling was conducted at the fill areas to determine the tendency of Site constituents to enter the atmosphere and local wind patterns. Air sampling data are subsequently evaluated in the HHRA (outdoor industrial worker, construction/utility worker and trespassing teenager exposure scenarios).

#### **Ecological Assessment Sampling Plan**

Ecological sampling was conducted to evaluate the impact of Site-related constituents on the potential ecological receptors (large mouth bass, great blue heron, bald eagle, mallard duck, muskrat and river otter). Fish filet data are also used in the HHRA (recreational fishing scenario).

#### **Pilot Treatability Test Sampling Plan**

Treatability studies were conducted on fill area waste materials to identify any characteristics of these materials that would prevent their treatment using off-Site incineration or on-Site thermal desorption technologies. Leachate treatability pilot testing was performed to determine the appropriate combination of physical/chemical and/or biological treatment processes that are needed to achieve pretreatment requirements for discharge to the American Bottoms publicly-owned treatment works (POTW).

### **1.2.2 EE/CA Objectives**

The USEPA intends to address all threats to human health and the environment (with the exception of ground water) at Area 1 using the EE/CA process. The objectives of the EE/CA are to develop, screen, and to perform a detailed evaluation of removal alternatives for media in areas that are determined to be acutely hazardous to human health and the environment. The purpose of removal actions generally is to respond to a release or threat of a release of hazardous substances so as to prevent, minimize or mitigate harm to human health and the environment. As cited in the preamble of the NCP (FR8695): "Although all removals must be protective of human health and the environment within their defined objectives, removals are distinct from remedial actions in that they may mitigate or stabilize the threat rather than comprehensively address all threats at a site." The removal objectives are consistent with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable considering the urgency of the situation and scope of the removal, and each selected removal alternative is analyzed for effectiveness, implementability, and cost. The alternative recommended herein for Area 1 is intended to be the final remedy.

### **1.2.3 RI/FS Objectives**

The primary objective of the RI/FS process is to gather information and provide evaluations and comparisons which are sufficient to support an informed risk management decision regarding the remedy selection for ground water. The RI evaluates all data and information developed during the implementation of the SSP, evaluates the hydraulic characteristics of the uppermost aquifer, and assesses risk to human health and the environment. The FS develops a list of remedial alternatives that will protect human health and the environment based on information that was collected during the RI and previous investigations. These alternatives are evaluated against nine criteria provided in 40 CFR 300.430 which are: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short term effectiveness; implementability; cost; State acceptance; and community acceptance.

### **1.3 Technical Approach**

The technical approach for this investigation included the review of data gaps identified by the USEPA and defined in the AOC SOW and collection of data to address these gaps. An Ecology and Environment (E&E) 1998 data compilation was reviewed, as was a 1989 E&E Site investigation report. However, because these previous investigations were conducted more than 10 years ago, a considerable amount of new data was collected from all media at the Site during the SSP. Historical data are not being used in the EE/CA and RI/FS because they do not reflect current conditions. Data collected during implementation of the SSP to fill data gaps and provide information needed for the HHRA, ERA, EE/CA and RI/FS included:

- **Waste Characterization**
  - Waste Depths
  - Extent of Cover over Fill Areas
  - Waste Volumes
  - Soil Gas Surveys
  - Magnetometer Surveys
  - Test Trenches/Borings
  - Leachate Samples
- **Ground Water**
  - Degree of Hazard and Mobility of Constituents
  - Recharge and Discharge Areas
  - Regional and Local Flow Direction and Quality
  - Local Uses of Ground Water
  - Horizontal and Vertical Distribution of Constituents
    - Fill Area Ground Water
    - Downgradient Alluvial Aquifer Ground Water
    - Bedrock Ground Water
    - Non-Potable Domestic Wells/Residential Ground Water
    - Slug Tests



- Grain Size Analyses
  - Upgradient Ground-Water Sampling
- **Soil**
  - Extent of Contamination in Undeveloped Area Surface Soils
  - Extent of Contamination in Undeveloped Area Subsurface Soils
  - Extent of Contamination in Developed Area Surface Soil Samples
  - Extent of Contamination in Developed Area Subsurface Soil Samples
  - Dioxin Sampling
  - Background Soil Samples
- **Sediments**
  - Extent of Industry-Specific Constituent Migration in Undeveloped Areas
  - Extent of Industry-Specific Constituent Migration in Developed Areas
  - Extent of Industry-Specific Constituent Migration in the Borrow Pit Lake/Old Prairie duPont Creek
  - Extent of Site-Specific Constituent Migration in Dead Creek
- **Surface Water**
  - Areas of Surface-Water Contamination in Dead Creek, Old Prairie duPont Creek, and Wetland Areas
- **Air**
  - Tendency of Constituents to Enter the Atmosphere and Local Wind Patterns
    - Volatile Organics
    - Semivolatile Organics, PCBs and Dioxins
    - Metals
  - Degree of Hazard
- **Ecological Assessment**
  - Affected Ecosystem Description
  - Evaluation of Toxicity in Creek Segments B, C, D and E
  - Evaluation of Toxicity in Site M Sediments
  - Evaluation of Toxicity in Creek Segment F

- Evaluation of Toxicity in Reference Areas
- Assessment of Endpoint Organisms
- Exposure Pathways
- Toxicity Testing or Trapping
- **Pilot Treatability Studies**
  - Off-Site Waste Incineration Treatability Evaluation
  - On-Site Waste Thermal Desorption Treatability Evaluation
  - Leachate Treatment Pilot Treatability Tests

A strategic technical approach was developed to analyze these data for use during the subsequent EE/CA and RI/FS. The outline of this approach is as follows:

- Collect and review data and information pertaining to Area 1 that were developed prior to this investigation;
- Review all documents pertaining to this investigation (SSP, AOC SOW, RI/FS and EE/CA Work Plans, and UAO) to ensure the intended investigations and reporting procedures previously concurred upon by Solutia Inc., the USEPA, and the Illinois Environmental Protection Agency (IEPA) are followed;
- Divide all data collected during this investigation into separate categories based on media (waste, ground water, soil, sediment, surface water and air);
- Analyze the data for each medium and identify trends as well as ranges for selected constituents;
- Develop a list of chemicals of potential concern (COPCs) and characterize their source, nature and extent;
- Conduct a Human Health Risk Assessment and an Ecological Risk Assessment for complete or potentially complete exposure pathways and potential receptors;
- Develop, screen, and perform a detailed evaluation of removal/remedial alternatives for media where appropriate;
- Identify the most feasible removal/remedial alternative based on the above analyses.

#### **1.4 Report Organization**

During the implementation of the SSP, it became apparent that environmental media evaluations to be completed independently under the EE/CA and RI/FS need to be addressed in a holistic manner in order to properly characterize media interactions and develop appropriate Site-wide removal or remedial alternatives. For example, the potential migration of Site constituents from fill areas needs to be evaluated in the context of subsequent impact on ground-water quality. Similarly, a response action selected to address potential contact exposure threats may also serve to mitigate migration pathways affecting other media and exposure scenarios. Based on these considerations and the similarities in the EE/CA and RI/FS report contents, as outlined in the SSP (Volumes 1D and 1E), these reports have been consolidated into a single document presented herein. A side by side comparison of the EE/CA and RI/FS report outlines contained in the SSP reinforces this observation:

<b>EE/CA Report Outline</b>	<b>RI/FS Report Outline</b>
Executive Summary	Executive Summary
Site Description and Background	Site Background and Description Past Disposal Practices Site Characteristics
Previous Removal/Remedial Actions	
Source Nature and Extent of Contamination	Nature and Extent of Contamination
Analytical Data	Summary Information on Investigations
Streamlined Risk Evaluation	Fate and Transport Risk Assessment
Identification of Removal Action Objectives	Remedial Action Objectives
Identification and Analysis of Removal Action Alternatives	Development and Screening of Alternatives
Comparative Analysis of Removal Action Alternatives	Comparative Analysis
Recommended Removal Action Alternative	

The site characterization portions of the EE/CA and the Remedial Investigation portions of the RI/FS are contained in Sections 1.0 through 8.0 of this document. Section 9.1 of this document contains identification and analysis of removal action alternatives in accordance with EE/CA guidance. The streamlined Feasibility Study for ground water is contained in Section 9.2. The report organization is depicted below:

Section 1.0:	Introduction
Section 2.0:	Background
Section 3.0:	SSP Investigation Description
Section 4.0:	SSP Investigation Results
Section 5.0:	Source, Nature and Extent of Contamination
Section 6.0:	Human Health Risk Assessment
Section 7.0:	Ecological Risk Assessment
Section 8.0:	Site Investigation Findings and Conclusions
Section 9.0:	EE/CA and FS

Section 1.0 provides an introduction of the project and states the project objectives, technical approach, and outline of this document. Section 2.0 discusses the background information at the Site including environmental setting, previous operations and disposal practices, and the previous and planned removal and remedial actions completed at the Site. Section 3.0 presents a summary of the SSP work elements completed for each medium at the Site and surrounding area. Section 4.0 presents the results from the SSP investigation. Section 5.0 provides an analysis of the source, nature and extent of constituents of potential concern in each medium based on analysis of data from the SSP. Sections 6.0 and 7.0 summarize the results of the Human Health and Ecological Risk Assessments, respectively. Section 8.0 presents the Site investigation findings and conclusions.

Section 9.0 presents the EE/CA and the FS and is organized as follows:

Section 9.1 Fill Areas (EE/CA)

Section 9.1.1 Identification and Screening of Technologies

Section 9.1.2 Detailed Analysis of Alternatives

Section 9.1.3 Comparative Analysis

Section 9.1.4 Recommended Alternative

Section 9.2 Ground Water (FS)

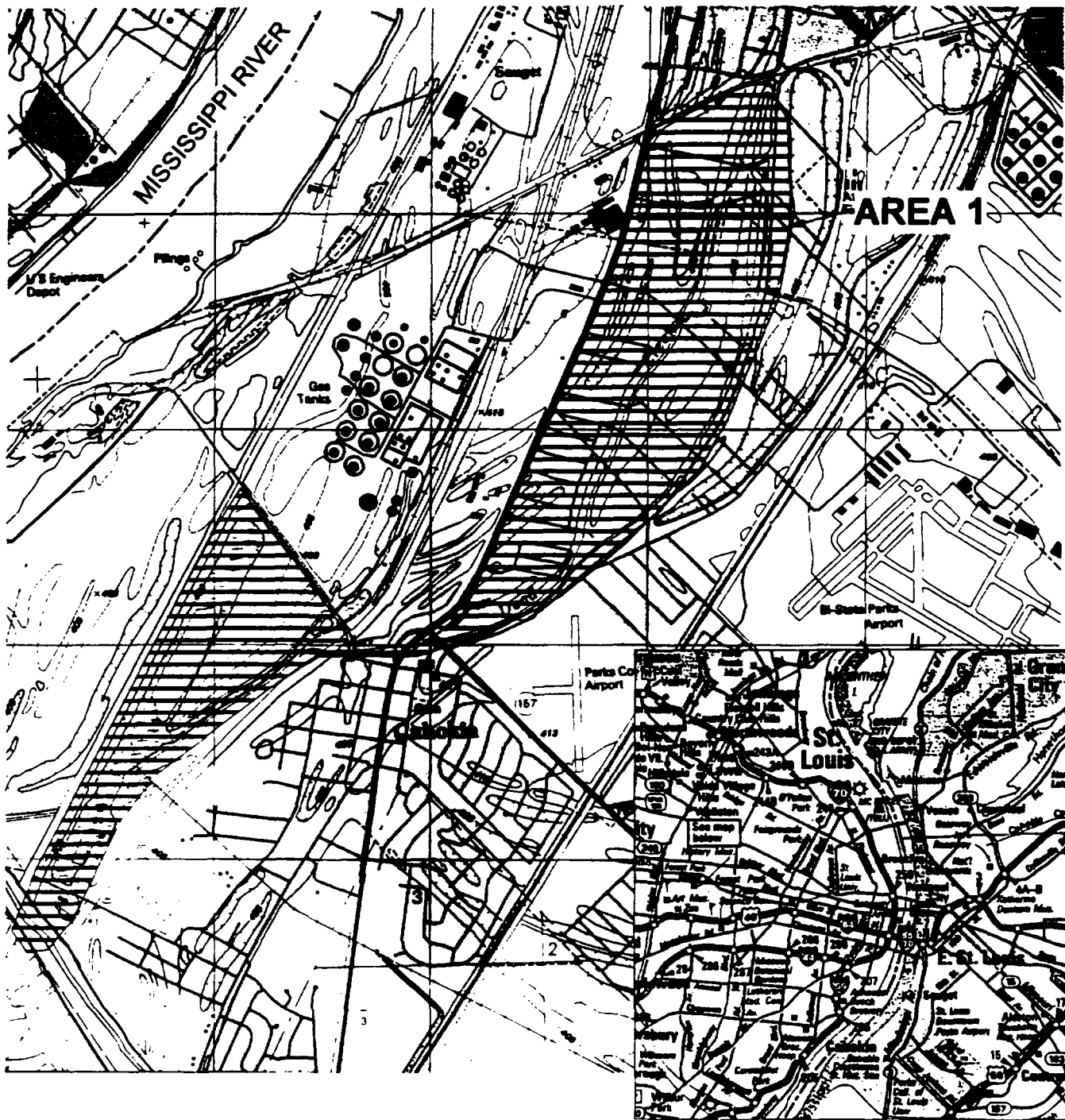
Section 9.2.1 Identification and Screening of Technologies

Section 9.2.2 Detailed Analysis of Alternatives

Section 9.2.3 Comparative Analysis

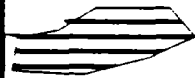
Section 9.2.4 Recommended Alternative

Section 9.1.1 identifies the remedial action objectives, describes general response actions, summarizes ARARs, and identifies technologies and processes to be considered for fill areas. Section 9.2.1 provides the same information for ground water. Section 9.1.2 presents alternatives for fill areas that are developed by grouping appropriate technologies, and evaluates these alternatives in the context of specific CERCLA criteria. Section 9.2.2 accomplishes the same for ground water. Sections 9.1.3 and 9.2.3 present a comparative analysis of the alternatives for fill areas and ground water, respectively. Section 9.1.4 presents the recommended alternative for fill areas, while Section 9.2.4 presents the recommended alternative for ground water.



SOURCE:  
U.S.G.S. CAHOKIA, IL-MO  
QUADRANGLE 1998  
7.5 MINUTE SERIES (TOPOGRAPHIC)

#### LEGEND



SAUGET AREA 1



#### SITE LOCATION MAP SAUGET AREA 1

SAUGET AND CAHOKIA, ILLINOIS

Prepared For

SOLUTIA

**ROUX**

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& Management

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Date 02/01

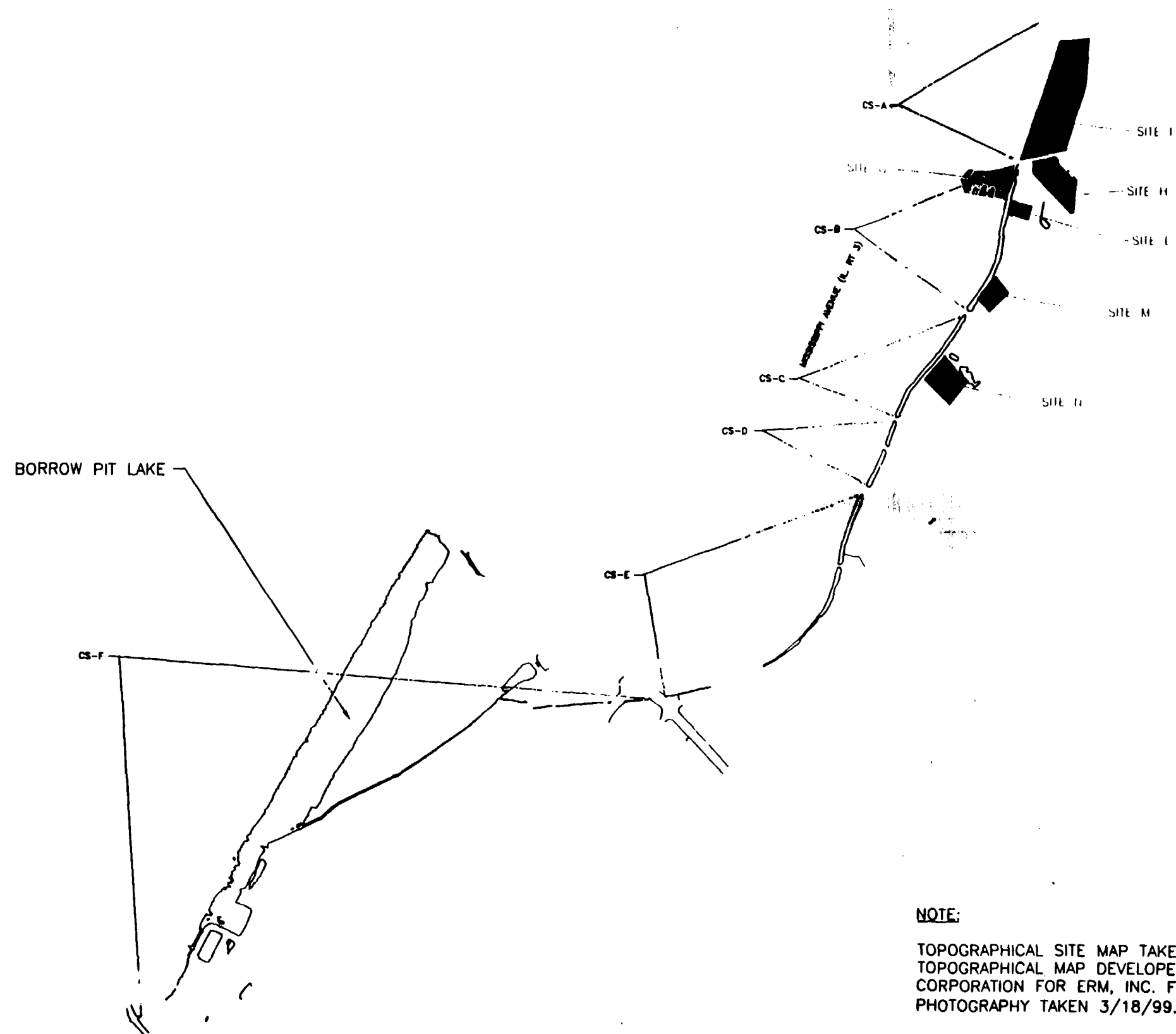
Scale 1"=2000'

Office TX

Project 00045704

FIGURE

1-1



**LEGEND**

 **FILL AREA**

 **CREEK SEGMENT WATER BODY**

**NOTE:**

TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL MAP DEVELOPED BY SURDEX CORPORATION FOR ERM, INC. FROM AERIAL PHOTOGRAPHY TAKEN 3/18/99.

SITES G, H, I, L, M, & N ARE APPROXIMATE FILL BOUNDARIES BASED ON AERIAL PHOTO REVIEW.

**SITE BOUNDARY MAP  
SAUGET AREA 1**

SAUGET AND CAHOKIA, ILLINOIS

Prepared For:



<b>ROUX</b> ASSOCIATES, INC. Environmental Consulting & Management	Compiled by: M.J.S.	Date: 02/01	<b>FIGURE</b>  1-2
	Prepared by: M.J.S.	Scale: 1"=1400'	
	Project Mgr: J.R.L.	Office: TX	
	File No: 46TD4.1-2	Project: 08846TD4	







## **2.0 BACKGROUND**

### **2.1 Environmental Setting**

Area 1 is located in the Villages of Sauget and Cahokia, St Clair County, Illinois. The following subsections provide a description of the Site features, climate, area physiography, topography, hydrology, hydrogeology, and surrounding land use and population.

#### **2.1.1 Site Location and Description**

The study area is centered on Dead Creek, an intermittent stream that is approximately 17,000 feet long, and its floodplain. Dead Creek is an urbanized drainage channel situated in an industrial and residential setting. Three closed municipal/industrial landfills (Sites G, H, and I), one backfilled waste-water impoundment (Site L), one flooded borrow pit (Site M), and one borrow pit backfilled with concrete rubble and demolition debris (Site N) are present in the study area. The study area also includes six Creek Segments:

Creek Segment A	Alton & Southern Railroad to Queeny Avenue (previously closed; not included in EE/CA or RI/FS)
Creek Segment B	Queeny Avenue to Judith Lane
Creek Segment C	Judith Lane to Cahokia Street
Creek Segment D	Cahokia Street to Jerome Lane
Creek Segment E	Jerome Lane to Route 157
Creek Segment F	Route 157 to Old Prairie du Pont Creek

These Sites and Creek Segments are shown on Figures 1-1 and 1-2 and are described in detail below using information from prior investigations. Background information presented below was previously reported in the SSP, which is the primary source of the information contained herein.

### **Site G**

Site G is located south of Queeny Avenue, east of (and possibly under) the Wiese Engineering facility, and north of a cultivated field in the Village of Sauget. Creek Segment B of Dead Creek is located along the eastern boundary of the site. Site G is approximately five acres in size, and was operated and served as a disposal area from sometime after 1940 to the late 1980s. The site was fenced in May 1988 pursuant to a USEPA removal action under CERCLA which was funded by potentially responsible parties, including Monsanto. Wastes located on the surface and/or in the subsurface of Site G spontaneously combusted and/or burned for long periods of time on several occasions prior to the removal action. The USEPA conducted a second CERCLA removal action at Site G in 1995. This removal action involved the excavation of PCB, organics, metals, and dioxin contaminated soils on and surrounding Site G, solidification of open oil pits on the site, and covering part of the site (including the excavated contaminated soils) with a clean soil cap approximately 18 to 24-inches thick. Site G is enclosed by a fence and is not currently being used. The property is vegetated.

Site G operated as a disposal area from some time after 1940 to 1966, and was subject to intermittent dumping thereafter until 1988, when the site was fenced. Prior to the current investigation, there were estimated to be 60,000 cubic yards of wastes within Site G, including oil pits, drums containing wastes, paper wastes, documents and laboratory equipment.

### **Site H**

Located south of Queeny Avenue, west of Falling Spring Road and west of the Metro Construction Company property in the Village of Sauget, Site H occupies approximately five acres of land. The southern boundary of Site H is not known with certainty, but it is estimated that the Fill Area extends approximately 1,250 feet south of Queeny Avenue. Site H is connected to Site I under Queeny Avenue, and together they were known to be part of the Sauget-Monsanto Landfill which operated from approximately 1931 to 1957 (Note: Sauget used to be known as Monsanto until the name of the village was changed in the

1950's). Site H is not currently being used, and the property is graded and grass covered with some exposed slag.

Due to the physical connection to Site I, waste disposal at Site H was similar to that at Site I. Industrial wastes were disposed here from approximately 1931 to 1957. Wastes included drums of solvents, other organics and inorganics, including PCBs, para-nitro-aniline, chlorine, phosphorous pentasulfide, and hydrofluosilic acid. Municipal wastes were also reportedly disposed at Site H. The estimated volume of waste in Site H prior to the current investigation was 110,000 cubic yards.

#### **Site I**

Located north of Queeny Avenue, west of Falling Springs Road and south of the Alton & Southern Railroad in the Village of Sauget, Site I was estimated to occupy approximately 19 acres of land. Creek Segment A of Dead Creek borders Site I on the site's western side. The site is currently graded and covered with crushed stone and used for equipment and truck parking. Site I was originally used as a sand and gravel pit which received industrial and municipal wastes. Site I is connected to Site H (see above) under Queeny Avenue and together they were known to be part of the "Sauget-Monsanto Landfill." The landfill operated from approximately 1931 to 1957. Wastes from Site I leached and/or were released into Creek Segment A and available downstream Creek Segments until Creek Segment A was remediated in 1990. (Note: The culvert between Creek Segment A and Creek Segment B was blocked in 1968. The culvert between Creek Segment B and Creek Segment C was blocked some time after 1932 and before 1943.) Site I served as a disposal area for contaminated sediments from historic dredgings of Dead Creek Segment A.

This site accepted industrial wastes from approximately 1931 to the late 1950s. Municipal wastes were also disposed in Site I. Site I was estimated to contain approximately 250,000 cubic yards of contaminated wastes and fill material prior to the current investigation.

#### **Site L**

Site L is located immediately east of Dead Creek Segment B and south of the Metro Construction Company property in the Village of Sauget. Site L is the former location of two surface impoundments used from approximately 1971 to 1981 for the disposal of wash water from truck cleaning operations. This site is now covered by cinders and is used for equipment storage. Site L wastes have migrated into Site M.

The volume of contaminated fill material in Site L is not known; however, the area of the impoundment is estimated to be 7,600 square feet.

#### **Site M**

Site M is located along the eastern side of Dead Creek Segment B (south of Site L) at the western end of Walnut Street in the village of Cahokia. Site M was originally used as a sand borrow pit in the middle to late 1940s. The pit is hydrologically connected to Dead Creek through an eight-foot opening at the southwest portion of the pit. Wastes from Dead Creek Segment B have in the past and potentially continue to migrate into Site M via this connection. The Site is currently fenced.

Site M was originally constructed as a sand borrow pit in the middle to late 1940s. This pit is approximately 59,200 square feet in size, and previous investigations indicated that approximately 3,600 cubic yards of contaminated sediments were contained within the pit. It is estimated that the pit is approximately 14 feet deep.

#### **Site N**

Site N is located along the eastern side of Dead Creek Segment C, south of Judith Lane, and north of Cahokia Street in the Village of Cahokia. This site encompasses approximately four acres of previously excavated land used to dispose of concrete rubble and demolition debris. The site is currently inactive and fenced.

Initially developed as a borrow pit in the 1940s, Site N has been filled with concrete rubble, scrap wood and other demolition debris. The depth of the fill may be as much as 30 feet.

#### **Creek Segment A (CS-A)**

Creek Segment CS-A is the northernmost segment of the creek. It was approximately 1,800 feet long and 100 feet wide, running from the Alton & Southern Railroad to Queeny Avenue. This segment of the creek originally consisted of two holding ponds which were periodically dredged. For several years, CS-A and available downstream segments (e.g., ones that were not blocked off) received direct waste-water discharges from industrial sources and served as a surcharge basin for the Village of Sauget (formerly the Village of Monsanto) municipal sewer collection system. When the system became backed up or overflowed, untreated wastes from industrial users of the sewer system were discharged directly into CS-A. On several occasions, CS-A was dredged and contaminated sediments were disposed onto adjacent Site I. In 1968, the Queeny Avenue Culvert, which allowed creek water to pass from CS-A to CS-B, was permanently blocked by the City of Sauget.

IEPA-approved remediation work was conducted by Cerro Copper in 1990 at CS-A. Approximately 27,500 tons (20,000 cubic yards) of contaminated sediments were removed to Resource Conservation and Recovery Act (RCRA) and Toxic Substance Control Act (TSCA) permitted facilities. CS-A is now backfilled and covered with crushed gravel. Before backfilling, a high density polyethylene (HDPE) membrane was installed in the excavated channel.

#### **Creek Segment B**

Creek Segment CS-B extends for approximately 1,800 feet from Queeny Avenue to Judith Lane. Sites G, L and M border this Creek Segment. Land use surrounding CS-B is primarily commercial with a small residential area near the southern end of this segment. Agricultural land lies to the west of the creek and south of Site G. Some time after 1932 and before 1943,

the Judith Lane culvert, which allowed creek water to pass from CS-B to CS-C, was blocked. CS-B is hydrologically connected to Site M by a manmade ditch (see Site M description).

#### **Creek Segment C**

Creek Segment CS-C extends for approximately 1,300 feet from Judith Lane south to Cahokia Street. Site N borders this Creek Segment. Land use is primarily residential along both sides of CS-C.

#### **Creek Segment D**

Creek Segment CS-D extends for approximately 1,100 feet from Cahokia Street to Jerome Lane. Land use is primarily residential along both sides of CS-D.

#### **Creek Segment E**

Creek Segment CS-E extends approximately 4,300 feet from Jerome Lane to the intersection of Illinois Route 3 and Route 157. Land use surrounding CS-E is predominantly commercial with some mixed residential use. Dead Creek temporarily passes through corrugated pipe at the southern end of CS-E.

#### **Creek Segment F**

Creek Segment CS-F is approximately 6,500 feet long and extends from Route 157 to the Old Prairie du Pont Creek. CS-F is the widest segment of Dead Creek, and a wetland area extends out from both sides of the creek. This area, known as the Borrow Pit Lake, is a long (6,000 ft) narrow (500 ft) rectangular water body that intersects CS-F near the midsection of the lake (Figure 1-2). Borrow Pit Lake is a borrow pit that was excavated during construction of a local levee system sometime after 1954. Water from CS-F discharges into the Borrow Pit Lake (downstream portion), and then to the Old Prairie du Pont Creek. The portion of Borrow Pit Lake that is located north of the CS-F discharge point (upstream portion) remains stagnant (little or no water flow) during periods of no or low precipitation.

### **2.1.2 Climate**

The climate of the study area is described by the National Climatic Data Center (NCDC) as a modified continental climate. The area is subject to four-season climate changes without the undue hardship of prolonged periods of extreme heat or high humidity. To the south is the warm, moist air of the Gulf of Mexico; and to the north, in Canada, is a region of cold air masses. The convergence of air masses from these sources, and the conflict on the frontal zones where they come together, produce a variety of weather conditions, none of which are likely to persist for any great length of time.

Winters are brisk and seldom severe. Records since 1870 show that the temperature drops to zero degrees Fahrenheit (0° F) or below on average two to three days per year. The area stays at or below 32° F for less than 25 days in most years. Average snowfall for the area is a little over 18 inches per winter season. Snowfall of an inch or more is received on five to ten days in most years. The long-term record for the St. Louis area (since 1870) indicates that temperatures of 90° F or higher occur on about 35 to 40 days per year, and extremely hot days of 100° F or more are expected no more than five days per year.

The normal annual precipitation for the area is slightly less than 34 inches. The winter months are the driest, with an average total of about 6 inches of precipitation. The spring months of March through May are normally the wettest with normal precipitation of just under 10.5 inches.

### **2.1.3 Physiography and Topography**

The Sauget Area 1 study area is situated in a floodplain of the Mississippi River called the American Bottoms. It is located on the eastern side of the river directly opposite St. Louis, Missouri. As a whole, the floodplain encompasses 175 square miles, is 30 miles long, and has a maximum width of 11 miles. It is bordered on the west by the Mississippi River and on the east by bluffs that rise 150 to 200 feet above the valley bottom. The floodplain is relatively



flat and generally slopes from north to south and from east to west. Land surface lies between 400 and 445 feet above mean sea level (MSL).

Locally across Area 1, the topography consists of nearly flat bottom land with slight irregularities. Elevations across the study area range from 400 to 410 feet MSL, and the land surface trends in a southeastward/northwestward direction.

#### **2.1.4 Drainage and Hydrology**

The Mississippi River, bordering the American Bottoms to the west, is the major surface-water body draining the area. It is fed by a complex network of natural and artificial channels which have undergone extensive improvement throughout the 20<sup>th</sup> Century. According to an investigation of ground-water resources conducted by the Illinois State Water Survey Division, at least 40 miles of improved drainage ditch have been constructed and the natural lake area in the center of the floodplain has been reduced by more than 40 percent.

Dead Creek serves as the main conduit for surface-water drainage through the Sauget Area 1 Site. The creek flows to a floodway south of Cahokia, which in turn discharges to the Cahokia Chute of the Mississippi River. Surface drainage across the study area is generally toward Dead Creek, although Site-specific drainage patterns are present:

- An emergency action response by the USEPA in 1995 resulted in the capping of Site G. Because of this, surface water flows radially away from the site.
- Drainage at Site H is typically toward Dead Creek, although the site contains several small depressions capable of retaining water. Water accumulating in these depressions due to precipitation infiltrates to ground rather than draining from the site across the surface.

- The majority of drainage at Site I is to the west. Water flows to an interceptor and is ultimately carried through a series of storm sewers and effluent pipes to the American Bottoms Regional Treatment Facility. Currently, stormwater runoff from the southern end of Site I drains to a catch basin on the north side of Queeny Avenue. This catch basin drains into CS-B.
- Drainage at Site L flows to the west toward the creek across a cover of highly permeable material (cinders).
- Site M is the recipient of surface runoff from a small residential area located to the southeast of the area. Surface water drains into Dead Creek through a cut-through located in the southwest corner of the site.
- Site N receives runoff from the surrounding area.

Flooding occurs in Area 1 during periods of significant precipitation due to low topographic relief, lack of a storm-water drainage system in developed areas and limited hydraulic capacity in Dead Creek resulting from under-sized road culverts. During such events, surface-water runoff is unable to drain sufficiently to prevent ponding and backup. The creek overflows at the same time that the banks and adjacent areas begin to flood due to lack of relief, resulting in flooding of the entire area.

## **2.1.5 Hydrogeology**

### **2.1.5.1 Regional Hydrogeology**

The American Bottoms are underlain by unconsolidated valley fill. The valley fill is composed of recent alluvium, known as the Cahokia Alluvium, which overlies a unit of glacial material known as the Henry Formation. The Cahokia Alluvium is approximately 40 feet thick and consists of unconsolidated, poorly sorted, fine-grained material with some local sand and clay lenses. These alluvial deposits unconformably overlie the Henry Formation which is composed of medium to coarse sand and gravel that increases in grain size with depth. This unit is approximately 95 feet thick and generally becomes thinner with increasing distance from the Mississippi River.

The valley fill throughout the floodplain is underlain by a bedrock system of Mississippian and Pennsylvanian age. The bedrock consists primarily of limestone and dolomite with some sandstone and shale, and is older in the central and western sections of the American Bottoms.

Two types of water-bearing formations that exist in the American Bottoms: unconsolidated and consolidated. The unconsolidated formations (predominantly silt, sand and gravel) are those that lie between the ground surface and the bedrock-gravel interface. The thickness of the unconsolidated formation varies throughout the area, but is typically estimated to be approximately 100 feet. Finer-grained sediments generally dominate at the ground surface and become coarser and more permeable with depth, creating semi-confined conditions within the aquifer. Thus, permeability and porosity increase in the unconsolidated formation with depth.

The consolidated formations are deep bedrock units of limestone and dolomite that exhibit low permeability and are not considered to be a significant source for ground water in the area.

As reported in "Ground-Water Management in the American Bottoms, Illinois," hydraulic properties of the unconsolidated aquifer have been determined from 10 aquifer tests and 100 specific capacity tests conducted on industrial, municipal, irrigation and relief wells. The coefficient of storage for the aquifer ranged from 0.002 to 0.155. Hydraulic conductivity values ranged from  $1.0 \times 10^3$  gallons per day per square foot (gpd/ft<sup>2</sup>) to  $3.0 \times 10^3$  gpd/ft<sup>2</sup>.

Recharge to the aquifer occurs through four (4) sources: precipitation, infiltration from the Mississippi River, inflow from the buried valley channel of the Mississippi River, and subsurface flow from the bluffs that border the floodplain on the east.

Historically, ground water from the American Bottoms aquifer was a major source of water for the area and was used for industrial, public, and irrigation purposes. Ground-water levels

prior to industrial and urban development were near land surface. Intensive industrial withdrawal and use and construction of a system of drainage ditches, levees, and canals to protect developed areas lowered the ground-water elevation for many years. However, by the mid-1980s, the ground-water levels increased due to reduced pumpage, high river stages, and high precipitation. Currently, no ground water is being pumped from the American Bottoms aquifer in the vicinity of Area 1 for public or industrial supply purposes. Nine individual residential wells have been identified near Area 1 and are listed in the SSP. These wells are used for irrigation purposes. Four were sampled as part of the SSP investigation. However, Cahokia and Sauget both have city ordinances that prohibit use of ground-water as potable water. The public water supply is the exclusive potable water source.

The source of drinking water for area residents is an intake in the Mississippi River. This intake is located at river mile 181, approximately three miles north of Dead Creek. The drinking water intake is owned and operated by the Illinois American Water Company (IAWC) of East St. Louis, and it serves the majority of residences in the area. IAWC supplies water to Sauget. The Commonfields of Cahokia Public Water District purchases water from IAWC and distributes it to portions of Cahokia and Centerville Township. The Cahokia Water Department also purchases water from IAWC and distributes it to small residential areas in the west and southwest portions of Cahokia.

The nearest downstream surface-water intake on the Illinois side of the Mississippi River is located at river mile 110, approximately 64 miles south of the project area. This intake supplies drinking water to residents in the Town of Chester and surrounding areas in Randolph County, Illinois. The nearest potentially impacted public water supply on the Missouri side of the river is located at river mile 149, approximately 28 miles south of Dead Creek. The Village of Crystal City, Missouri (pop. 4,000) located 28 miles south of Dead Creek, utilizes a Ranney well adjacent to the Mississippi River as a source for drinking water.

Although agricultural land is found throughout the immediate project area, this land is apparently not irrigated. The nearest irrigated land, other than residential lawns and gardens,

is located in the Schmids Lake-East Carondelet area, which is south of Old Prairie du Pont Creek.

#### **2.1.5.2 Site Hydrogeology**

Area 1 is located in the southwestern section of the American Bottoms floodplain. More specifically, it is situated south of East St. Louis, and is approximately three-quarters to one mile east of the eastern bank of the Mississippi River. The stratigraphy beneath the Site is much like that of the rest of the floodplain. The Cahokia Alluvium is about 30 feet thick and exists as a fine silty sand that is gray and brown in color. Below this, the unconsolidated deposits of the Henry Formation are present. Locally, the Henry Formation is characterized by medium-to-coarse sand that becomes coarser and more permeable with depth. The thickness of this unit ranges from 140 feet near the river to about 100 feet on the east side of the Site. The ground-water level is currently between 10 to 20 feet below ground surface, but fluctuates during times of heavy and light precipitation. Figure 2-1 presents a generalized cross-section of the Site hydrogeology.

Geologic data show that the unconsolidated deposits range from 140 feet thick near the river to about 100 feet in the eastern part of Sauget Area 1. At most locations, the contact between Cahokia Alluvium and the Henry Formation can not be distinguished. However, three distinct hydrogeologic units can be identified: 1) a Shallow Hydrogeologic Unit (SHU), 2) a Middle Hydrogeologic Unit (MHU), and 3) a Deep Hydrogeologic Unit (DHU). The 30 feet thick Shallow Hydrogeologic Unit includes the Cahokia Alluvium (recent deposits) and the uppermost portion of the Henry Formation. This unit is primarily an unconsolidated, fine-grained silty sand with low to moderate permeability. The 40 feet thick Middle Hydrogeologic Unit is formed by the upper to middle, medium to coarse sand portions of the Henry Formation. It contains a higher permeability sand than found in the overlying Shallow Hydrogeologic Unit, and these sands become coarser with depth. At the bottom of the aquifer is the Deep Hydrogeologic Unit which includes the high permeability, coarse-grained deposits of the lower Henry Formation. This zone is estimated to be about 30 to 40 feet

thick. In some areas, till and/or boulder zones were encountered 10 to 15 feet above the bedrock.

Aquifer tests performed at Area 1 over a span of 30 years have established characteristics such as transmissivity, hydraulic conductivity, storage coefficient and ground-water velocity. Tests have been conducted for all three (3) ground-water units and are summarized as follows:

	Transmissivity gpd/ft	Hydraulic Conductivity	Storage Coefficient
Shallow Hydrogeologic Unit	141.5 gpd/ft	9.5 gpd/ft <sup>2</sup> (4 x 10 <sup>-4</sup> cm/s)	Not Available
Middle Hydrogeologic Unit	165,000 gpd/ft	3,300 gpd/ft <sup>2</sup> (1.6 x 10 <sup>-1</sup> cm/s)	0.04
Deep Hydrogeologic Unit	211,000 gpd/ft	2,600 gpd/ft <sup>2</sup> (1.2 x 10 <sup>-1</sup> cm/s)	0.002 to 0.100

Note: Results are averages.

#### 2.1.6 Surrounding Land Use and Population

Heavy industry has located on the east bank of the Mississippi River between Cahokia to Alton, Illinois for nearly a century. Industrial activity peaked in the 1960s, although heavy industry has shut down throughout the American Bottoms, the Sauget area is still highly industrialized. In addition to heavy industry, the area currently has warehouses, trucking companies, commercial facilities, bars, nightclubs, convenience stores and restaurants.

Active and inactive industrial facilities are located upgradient of Area 1 (Mobil, Sterling Steel, T. J. Moss). Former industrial facilities (Midwest Rubber and Darling Fertilizer), bulk storage areas (Eagle Marine and Slay Terminals), waste disposal areas (Sauget Area 2 Sites Q and R), waste treatment facilities (Trade Waste Incineration), a chemical reprocessor (Resource Recovery Group), closed sludge lagoons (Sauget Area 2 Site O) and active waste-water treatment plants (P/Chem Plant and American Bottoms Regional Treatment Facility) are

located downgradient of Area 1. Active industrial facilities are located on its north (Ethyl Corporation, Big River Zinc) and south sides (Cerro Copper). Descriptions of each of the major industries, formerly or currently operating in the Village of Sauget are given below. Locations of the facilities are shown on Figure 2-2.

**Big River Zinc** – Big River Zinc (formerly Amax Zinc), processes zinc sulfide concentrates (containing 60% zinc, 20% sulfur, 3% lead, 0.98% iron and 0.6% cadmium) into various zinc products including refined zinc metal cast into slabs, blocks and logs; zinc alloys; zinc powders; zinc sulfate monohydrate and zinc oxide. Sulfuric acid, copper, nickel, cobalt and cadmium were also produced at this facility. Opened in 1929, the plant shut down in 1971 but was refurbished and reopened in 1972.

Prior to 1972, the facility stored residue from leaching operations in on-site impoundments. These wastes likely contained inorganics and heavy metals. In 1987, the IEPA conducted a "Potential Hazardous Waste Site Preliminary Assessment" for the plant. The report noted that the storage of residues from leaching operations in lagoons could have resulted in infiltration of residue into the ground water. Additionally, run-off from the plant and seepage from the lagoons could have resulted in surface-water contamination. Soil samples taken within the plant in 1988 indicated the presence of lead, arsenic, cadmium, chromium, zinc and nickel.

**Cerro Copper** – Cerro Copper Products Company operates an integrated copper recycling plant using copper from many sources. In the past, Cerro received copper coils from transformers. It also scrapped PCB transformers on its property and drained the PCB oil into Dead Creek which bisected Cerro's property before it was remediated in 1990/1991. Sauget Area 1 Site I is located on Cerro's property. Samples on Cerro's property revealed the presence of VOCs, SVOCs and metals.

**Clayton Chemical** – Clayton Chemical, which is now owned by the Resource Recovery Group (RRG), is located west of Sauget Area 1. The property was utilized from 1930 to 1962 as a railroad repair yard. Types of waste that may have been generated and disposed on site during this time frame are those typical of a rail yard in those years, including off-specification or contaminated fuels, used lubricating oil, waste wash water, etc. In 1962, a crude oil topping plant began operations on site. Products derived from the crude oil included white gas, distillate fuel oils, and residual bottoms material. Wastes from these processes were disposed on site.

Other on-site operations resulted in disposal of waste oil on site. Soil sampling in the area of above-ground tanks detected PCBs and pentachlorophenol.

**Darling Fertilizer** – Darling was in the business of manufacturing chemical fertilizers. The process appears to have involved acidulation of phosphate rock and the subsequent blending of the rock with nitrates, lime, etc. Darling abandoned operations sometime after 1965.

**Ethyl Petroleum Additives, Inc.** – Ethyl Petroleum Additives, Inc. is located immediately north of the Solutia W. G. Krummrich Plant. In 1940, Monsanto sold land that is now owned by Ethyl to the federal government. Construction of a plant to manufacture chemicals for use during World War II began shortly thereafter and was completed by early 1942. Monsanto then entered into a contract with the federal government (via the Chemical Warfare Service) to manufacture a product, known as CC-2, that was used to impregnate soldiers' clothes during the war to protect them from chemical warfare agents. Raw materials used to manufacture CC-2 included chlorine, sulfuric acid, aniline, urea and hydrochloric acid. The manufacture of CC-2 resulted in various spills and leaks, which likely impacted soil and ground water. At the end of the war, the impregnate processes were stopped.



In 1946, Monsanto entered into a lease with the government for operation of the plant. Pursuant to this lease, Monsanto produced 2,4-D, DDT, Santolube® and alkylbenzene. In 1960, the government sold the plant to Monsanto. In 1971, Monsanto sold the facility to Edwin Cooper & Co., which continued to operate a petroleum additives business at the facility. In 1975, Ethyl Corporation purchased Edwin Cooper.

E&E conducted a Screening Site Inspection of the facility in 1990. Sample results indicate increased concentrations of metals, including aluminum, iron, magnesium, potassium and zinc.

**Midwest Rubber** – Midwest Rubber began operations in 1928. The company reclaimed rubber, principally from discarded automobile tires by heating the tires in autoclaves with caustic solution or chloride solution. Midwest Rubber's wastes included rubber, pine tars, and naphthalene. Until 1965, Midwest Rubber burned rubber that adhered to wires present in the tires. Burning ceased in 1965 and the residue was hauled away for disposal. One witness stated that the wastes were deposited in Site I.

**ExxonMobil** – Mobil Oil Refinery (Mobil) is located northeast of Sauget Area 1. In 1917/1918, a refinery was constructed on this property for the processing of lubricating oil. By 1940, production expanded to about 12,000 barrels per day, and the refinery added new equipment including four oven coke plants, a Houdry Gas Plant, and a new Gasoline Treater. Between 1942 and 1944, the refinery began necessary alterations for the production of aviation gasoline needed for World War II.

By 1961, production increased to 55,000 barrels per day, with coke production at a rate of 8,000-13,000 tons per month. Although the refinery closed in 1970, operations at the Sauget Terminal expanded. Mobil Oil operated throughout the 1980s as a terminal for unleaded gasoline and #1 and #2 fuel oils. Product was received via two pipelines and a barge terminal and distributed via trucks loaded at the terminal. Tanks, which were filled by pipeline, ranged in size from 1,555 to 133,000 barrels. As of 1993, the Sauget Terminal operated a barge

dock that transported product from Joliet to Sauget, handled 200,000,000 gallons of #1 and #2 fuel oil and gasoline for several petroleum companies and ultimately generated 100 to 1000 kilograms per month of hazardous wastes.

Based on information from Mobil retirees and documents, the following operations resulted in releases to soil and ground water: 1) on-site kilns, 2) residual process waste disposal, 3) oily waste piles, 4) loading racks flushed with gasoline, 5) railroad tank car loading, 6) skimmer ponds used as traps to collect liquids including overflow from alkylation units, 7) sludge placed in ponds or lagoons and 8) tank bottoms disposal in trenches. Wastes generated at the site included sludge, tank bottoms, other oil wastes, acids from caustic treating solution and heavy metals. Wastes from the operations were deposited in Sauget area landfills.

In 1940/1941, when installing on-site water supply wells, Mobil had to pump oil out of the ground. In a 1952 well test, a black gummy oil was found at seven feet, and at 13 feet oil was "showing."

In 1981, Woodward-Clyde conducted a site investigation of Mobil's North Tank Farm to evaluate potential impact from past operations. This investigation concluded that past spills and buried oily sludges had resulted in impact to soil and ground water. Traces of oil and oil film were observed in some of the monitoring wells on site. The investigation report concluded that oil could be seeping into the wells from buried sludges and that the wells could be acting as conduits for the transmission of impacted surface water and oil from buried sludges to the ground water. The ground surface at several locations appeared to be stained with oil as a result of past leaks or spills. Oily sludge was observed caked on the surface near the oil recovery pits at the west end of the site. Petroleum was also observed seeping from beneath a railroad tie retaining wall.

In 1994, underground storage tank (UST) closure activities were completed at the site, including removal of four USTs in the main terminal area (the crude oil refinery) and two USTs at the East Tank Farm (the bulk storage terminal). A release of hydrocarbons had occurred at each of the tanks. Benzene, toluene, ethylbenzene, and xylenes (BTEX), and polynuclear aromatics were detected in the soil. BTEX and polynuclear aromatics were detected in a ground-water sample from the East Tank Farm, and polynuclear aromatics were detected in a ground-water sample from the Main Terminal Area.

The refinery closed in 1970, but operations continued at the Sauget Terminal until 1993. Over the years, operations at Mobil's facilities resulted in various leaks and spills to the ground, all of which could have impacted ground water.

**Rivers Edge Landfill** – Industrial Salvage and Disposal, Inc. (ISD), whose name was later changed to Sauget Co., operated the Rivers Edge Landfill (Sauget Area 2 Site R) for Monsanto from 1958 to 1977 for disposal of hazardous and non-hazardous bulk liquid and solid chemical wastes and drummed industrial wastes from the Monsanto William G. Krummich Plant and, to a lesser degree, Monsanto's J.F. Queeny plant in St. Louis. Disposal began in the northern portion of the site and expanded southward. An average of 15,000 cubic yards per year of waste material was disposed in the landfill. In 1979 the landfill was covered with a clay cap that varies in thickness from 2 to 8 feet.

**Sauget Landfill** – In the late 1950s the Sauget family began the operation of the Sauget Landfill (Sauget Area 2 Site Q) which was located south of the Rivers Edge landfill previously operated by ISD, along the banks of the Mississippi River. It continued in operation until the 1970s. This landfill took plant trash from Monsanto, as well as waste from many other industrial facilities, demolition debris and municipal wastes.

**Sterling Steel** – Sterling Steel Foundry, Inc. is located northeast of Sauget Area 1. Operations began at the site in 1922 as Sterling Electric Steel Casting Co. Sterling Steel used the following raw materials in its operations: manganese, chromium, nickel, molybdenum and silicon. It disposed of casting sand, demolition debris, scrap metal in unlined pits and surface disposal areas at least from 1973 through 1978. One pit is located at Sauget Area 1 Site J, with another located near the facility's incinerator. Initial excavations of these disposal pits occurred in the 1950s. A 1986 E&E report noted that there was a high metal content in the wastes in the Site J area. Wastes from the facility also included spent foundry sand, popcorn slag and quench water scale. Cooling water from electric furnaces, compressors and air conditioning was discharged into the 24" sewer line at the north end of Dead Creek.

By 1982, the foundry conducted smelting by melting scrap steel in an induction furnace, then pouring it into molds lined with a mixture of sand and bentonite clay. The sand and bentonite clay mixture was then disposed on the property. In 1982, after a brief shutdown, the facility was bought by St. Louis Steel Casting.

A 1986 soil gas survey conducted by E&E revealed volatile organic gases in concentrations ranging from 65 mg/L to over 1000 mg/L. Surface soil samples also indicated the presence of nickel (377 mg/kg) and chromium (500 mg/kg). Subsurface soil samples indicated the presence of ethylbenzene, xylene, 1,4-dichlorobenzene, dibenzofurans, phenanthrene and Aroclor 1260. The highest organic concentration was 110 mg/kg near the southeast corner of the disposal area. A 1993 CERCLA Site Screening Inspection included on-site surface soil and sediment samples. PCBs were found in almost all samples; and arsenic, barium, beryllium, cadmium, copper, mercury, nickel and thallium were identified at levels above background and normal soil ranges. A 1996 Phase II Investigation conducted by Rust Environmental revealed arsenic, barium, cadmium, chromium and lead in ground water. The report concluded that these levels were associated with metal manufacturing and could have resulted from the fill material at adjacent areas.

**T.J. Moss** – The T.J. Moss Tie Company, now owned by Kerr McGee Chemical corporation (Kerr McGee) is located upgradient of Sauget Area 1. Moss Tie began as a wood treating operation at this location in 1927. The plant operated from 1927 through 1968, treating wood products such as railroad ties and utility poles with creosote, pentachlorophenol and other preservatives. Operations at the plant under T.J. Moss and its successor Kerr McGee, were essentially identical. The plant used creosote and "...5% Pentachlorophenol ("penta") in #2-4 diesel." Creosote solutions were utilized over the entire operating history of the plant. Penta was only used from the early 1950s until the plant's closing.

Various inspections during the 1980s and 1990s revealed areas of impacted soil throughout the facility. For example, a 1986 inspection revealed that the north impoundment sludge and soil samples contained moderate to high levels of polyaromatic hydrocarbons (PAHs), while the south impoundment sludge sample contained 40.4 mg/kg of pentachlorophenol and moderate levels of PAHs. A 1988 to 1990 Remedial Investigation indicated that soil and ground water were impacted primarily in the pond, process, and drip track areas along the southwestern and eastern half of the site. This investigation detected the following constituents: benzene, toluene, ethylbenzene, xylene, phenol, pentachlorophenol, cresols, naphthalene and other PAHs. Free product was encountered in four shallow monitoring wells adjacent to the ponds, process and drip track areas and in the deep monitoring wells adjacent to the north pond and process area.

A July 1993 ground-water quality monitoring event also noted free product mixed with water within the Cahokia Alluvium in various monitoring wells near the ponds, process, and drip track areas. For the Lower Henry Formation, free product was observed above the top of bedrock in one monitoring well in the north pond area. Creosote saturated soils were found beneath the north pond sludge and process area and drip track pad. In 1991, the volume of impacted soil was estimated to be 788,190 cubic yards containing 2,584,030 pounds of PAHs.

**Union Electric** – From 1923 until 1979, Union Electric operated a large electric generating station on the east bank of the Mississippi River. A large electrical substation, operated by Ameren/UE, is located to the east of the generating station. The power plant used coal for fueling its boilers until it switched to oil in the 1960s. Ash from the plant was disposed in large ash ponds on property south of the plant. The plant also contained PCB-filled transformers both in the plant building and in the yard. Currently the facility is operated as a barge and rail loading and unloading facility. Products handled included coal and various chemicals.

**Village of Sauget Waste Water Treatment Plant (WWTP)** – Sauget Area 2 Site O is the location of the old Sauget Waste Water Treatment Plant (P-Chem Plant) sludge lagoons. The 20-acre site consists of four covered sludge dewatering lagoons associated with the old WWTP. Documents indicate that the WWTP began operations in 1952. The sludge lagoons at Site O were opened in 1965, and were placed in operation in 1966/1967. A 1988 report on the Sauget area states that “[a]pproximately ten million gallons per day (gpd) of waste water was treated at this facility, of which over 95 percent of the influent came from industrial sources.”

A Notification of Hazardous Waste form was submitted to the USEPA by the Village of Sauget in 1981 which explained that the lagoons were used for disposal of clarifier sludges from 1965 to approximately 1978. The sludge lagoons were closed in 1980 by stabilizing with lime and covering with two feet of clay. In 1982, the IEPA sampled filter cake sludge from the WWTP. The sample results showed that several organics, including chlorobenzene, xylene and aliphatic hydrocarbons were present in sludges. Additional soil and ground-water sampling was conducted by E&E at Site O in 1986/1987. The results of the sampling were documented in the May 1988 Expanded Site Investigation Report. The soil sampling indicated that much of the sludge material was probably removed prior to capping but organics were present in the residual material.

**William G. Krummrich Plant** – Solutia's William G. Krummrich Plant is located north of Sauget Area 1. Chemical manufacturing began in 1907 when the Commercial Acids Company constructed facilities to manufacture commodity chemicals including sulfuric, muriatic and nitric acids. In 1914, the Commercial Acids Company purchased a neighboring facility, the Sandoval Zinc Company, and added zinc chloride to its product line. Production of phenol by the sulfonation process started in 1916. Monsanto purchased the Commercial Acids Company in November 1917 and called it Plant B. Through this acquisition, Monsanto gained a product line that included the heavy acids and zinc chloride as well as phenol, salt cake and nitric cake. These products remained the total line of Plant B until 1925 when it began producing chlorine and caustic soda. The following year, facilities were added for the production of chlorobenzenes, para-nitroaniline, and catalysts for contact sulfuric acid plants.

Expanding rapidly during the 1930s, William G. Krummrich added nitrated organic chemicals, chlorophenols, benzyl chloride, aroclors, hydrogenated products, phosphorus halides and phosphoric acid to its product line. In 1932, the Village of Monsanto installed sewers and William G. Krummrich's process sewers were tied into the village system. Product line expansion was halted during World War II, when emphasis was placed on maximizing production of existing products to support the war effort. During this period, 15 acres of land were sold to the United States government as a site for the construction of a chemical warfare plant. Two years after the end of World War II, Plant B leased the Chemical Warfare Service Plant from the US government (1947) and began producing 2,4-D and 2,4,5-T weed and brush killers. Later in the 1940s, production of the detergent ingredients Santomerse® #1 and alkylbenzene began.

Expansion continued in the 1950s when the plant began producing potassium phenyl acetate (1950), monochloroacetic acid (1951), tricresyl phosphate (1954), adipic acid (1954), phosphorus pentasulfide (1955), fatty acid chloride (1956) and Santolube® 393 (1956). In 1951, Plant B's name was changed to William G. Krummrich to honor a plant manager.

In 1960, Monsanto purchased the U.S. government's Chemical Warfare Service Plant, and expansion of William G. Krummrich continued. New units were built for the production of a germicide and an oil additive, a nitration facility and a modernized phenol production unit. In 1963, facilities for the production of chlorinated cyanuric acid compounds came on stream and a new chlorine unit expanded output to 100 tons of chlorine, 70 tons of caustic soda, and 55 tons of potash per day. A new ortho-dichlorobenzene unit was completed in 1964, the same year that the first commercial biodegradable detergent intermediate was made in a modified unit.

The Plant River Terminal, constructed circa 1960, had two tanks for storing sulfuric acid, and one tank each for storing toluene, caustic soda, monochlorobenzene and fuel oil. The only other structure at the River Terminal was a boiler house used to supply steam to keep tanks, pumps and piping from freezing. Several pipelines originated at this location, traversed property owned by others, crossed Lot F and passed under Route 3 at a point about even with William G. Krummrich's West Gate. The pipelines were used to transfer benzene, sulfuric acid, and toluene from the river dock to the plant process area.

In 1966 a laboratory, primarily used for quality control and process research, began operation at the plant. A new sulfuric acid production unit was finished in 1967, replacing two smaller manufacturing units. Expansion of the para-nitrochlorobenzene production unit was also completed in 1967, leading to a 50 percent increase in production. In 1968, William G. Krummrich began the production of calcium benzene sulfonate (Santolube® 290). 1968 also saw the expansion of the aroclor, nitrochlorobenzene and ortho-nitrophenol production units.

Final shutdown of the Phenol Department, which had operated for 54 years, occurred in 1970, and the Santosite® facilities were updated to increase production. In 1971, a subsidiary of Ethyl Corporation purchased the section of the plant known as the North Area (approximately 24 acres) for the production of petroleum additives. This area included the former chemical warfare plant. The Ortho-nitrophenol Department came on stream in 1972.



A new Benzyl Chloride/Santicizer® 160 Plant became operational in 1976, replacing an older plant. The Aroclor and Santosite® Departments ceased production and were dismantled in 1977 and 1979, respectively. In 1981, the Santicizer® 160 and butyl benzyl chloride units ceased operations and were decontaminated and decommissioned. The departments were not dismantled since they were planned to resume operation when market conditions improved. However, the market did not improve, and in 1986 the department was converted to produce a rubber chemical product called Santoflex®. In the mid 1980s, chlorine manufacturing ceased at William G. Krummrich and the remaining chlor/alkali facilities were dismantled.

In the 1980s the Plant River Terminal was dismantled and the pipelines leading to the plant were drained, flushed, and filled with grout.

In the early 1990s, the Ortho-Nitrophenol and the Phosphorus Trichloride Departments ceased operation and were dismantled. Also in the early 1990s two businesses that operated at William G. Krummrich changed ownership: 1) Occidental Chemical Corporation (OxyChem) purchased the ACL (swimming pool chlorine) business, and 2) Flexsys, a joint venture between Akzo Nobel and Monsanto, assumed ownership of the 4-nitrodiphenylamine and Santoflex® production units.

In 1997 Monsanto spun off its chemical business to form Solutia Inc., and William G. Krummrich became part of Solutia. In 1999, Flexsys halted production of 4-nitrodiphenylamine (NDPA). The powerhouse, which generated steam and some electrical power for William G. Krummrich, was also shut down in 1999. Demolition of both 4-NDPA and the powerhouse started in 2000. In 2000, Solutia and FMC Corporation formed a joint venture called Astaris combining both companies' phosphorus businesses. Astaris is the current owner of the phosphorus pentasulfide production unit which is operated by Solutia.

### **Current Industrial Operations**

Industrial facilities currently operating in the vicinity of Sauget Area 1 are listed below:

<u>Company</u>	<u>Business Line</u>
Astaris	Phosphorus Pentasulfide
Big River Zinc	Zinc Smelter
Cahokia Marine Services	Bulk Storage
Cerro Copper	Copper Smelter
Ethyl Corporation	Petroleum Additives
Flexsys	Rubber Chemicals
Mobil Oil Company	Bulk Storage
OxyChem	Swimming Pool Chlorine
Phillips Petroleum	Bulk Storage
Resource Recovery Group	Waste Recycling
Slay Terminals	Coal Storage
Solutia	Chlorobenzene
Sterling Steel Castings	Foundry
Trade Waste Incineration	Hazardous Waste Treatment
Union Electric	Electricity Distribution

The primary land use in the vicinity of Sauget Area 1 is industrial, with over 50 percent of the land being used for this purpose. In addition, small residential, commercial, and agricultural properties are interspersed throughout the town of Sauget. There is a residential area adjacent to Sites H and I. The closest residence is located approximately 200 feet east of these sites, and the Sauget Village Hall is located adjacent to Site I. There are also two small cultivated fields located south of Sites G and L. These fields are used for soybean production and separate the sites from a residential area in the northern part of Area 1.

## **2.2 Waste Disposal**

The following subsection provides a description of the liquid, solid, and waste-water disposal activities associated with companies that previously placed waste in Area 1 and that are known to date. Many facts are still unknown.

### **2.2.1 Liquid and Solid Waste Disposal**

Documentation of disposals at Sites G, H, I, L, M and N in Sauget Area 1 is limited. While Monsanto has submitted information to the USEPA that documents its disposals into Site I, no other area industry has presented such information despite the fact that many industries throughout the metropolitan area were using these sites. The following sets forth the limited knowledge available:

**American Zinc (AMAX)** A former Monsanto employee stated to the IEPA that American Zinc dumped material in Sauget. The waste included copper cake containing copper, nickel and cobalt.

**Chemical Warfare Service (CWS)** The CWS plant operated and owned by the government was in operation while Sites H and I were being used as landfills and possibly while disposal was occurring at Site G. Wastes from this operation were disposed in Sites H and I. It is possible that wastes were also disposed in Site G.

**Cerro Copper** Cerro used slag from its blast furnaces as fill at Site I. Cerro Copper used solvents in its processes and these solvents were disposed in Sauget.

**Darling Fertilizer** The Darling plant was operated from sometime in the early 1900s (it was in operation at least by 1929) until 1965. Based on this time frame and its location, it is likely that wastes from the Darling plant were disposed in Sites G, H, and I.

**Edwin Cooper** Edwin Cooper began operations at Sauget in 1969. It produced crankcase, gear and hydraulic lubricant additives. Waste generated at the site included diatomaceous earth used to filter products. Prior to 1973, the disposal method and location of this waste are unknown. An IEPA permitted landfill (Sauget Area 2 Site P) was operated by Sauget and Company from 1973 to approximately 1980 on a site north of Monsanto Avenue and west of Route 3 at or near the current location of PT's Sports Bar. This 20-acre landfill accepted non-chemical wastes from Monsanto and general waste and diatomaceous earth filter cake from Edwin Cooper, Inc. (now Ethyl Corp.)

**Midwest Rubber** Midwest Rubber's waste included rubber, pine tars, and naphthalene. Until 1965, Midwest burned rubber that adhered to wires present in tires. Burning ceased in 1965, and the residual was hauled away, possibly to landfills in Sauget. The USEPA has found that tire combustion is a source of dioxin. In addition, combustion of tires at the site has caused dense smoke that contained lead, arsenic, cyanide, benzene, PAHs, ethyl mercaptan and other compounds which are contaminants found at Area 1. Furthermore, Midwest used PCBs in equipment on site. Waste PCB oil could have been disposed in Area 1.

**Monsanto** Monsanto submitted a 103 (c) notice in 1981 which identified the "Sauget (Monsanto) landfill" on Falling Springs Road as receiving wastes from both the William G. Krummrich plant and the Queeny plant in St. Louis from an unknown date until 1957. These notices indicated that the type of wastes disposed in the landfill included organics, inorganics, and solvents. Based on documents in Monsanto's 104(e) response, the wastes disposed at this landfill were waste chemicals, residue, filter aid, waste paper, paper sacks, floor sweepings, garbage, cardboard, fiber packs, steel drums, scrap building materials, etc. Because both the William G. Krummrich and the Queeny plants used other disposal sites for their wastes, the exact nature and amount of disposal at the Area 1 landfills is unknown.

**Mobil** In answers to a 104(e) request, Paul Sauget stated that Mobil disposed of material at one or more of Sites G, H, and I. Witnesses confirmed Mobil's disposals in Sites H and I. Mobil disposed of sludges and beads from its filtering operations. Mobil likely used PCBs in its processes since 54 ppb of PCBs were found in Mobil's sewer effluent in 1971. During the excavations at Site G, a large volume of oily sludges and tar-like wastes were found. Because of the volume, it appeared that the material originated from a large refinery operation.

**Rogers Cartage** Rogers Cartage owned and operated a portion of Site H from 1968 to 1979. Those operations likely resulted in the release of tank washings on to the ground at the site. The products hauled by Rogers Cartage are listed in Section 2.2.2.

**Sterling Steel** Sterling Steel operated in Sauget from 1922 to the present. Its processes produced waste that included spent foundry sand and popcorn slag. The sand has been found to be extraction procedure (EP) toxic for metals.

**T.J. Moss/Kerr McGee** From 1927 to 1968, T.J. Moss operated a plant in Sauget that treated wood products such as railroad ties and utility poles in a process that involved treating the wood with creosote, pentachlorophenol and other preservatives. Untreated wood waste was allegedly burned in the plant's boiler for heat recovery. Waste waters and storm water were impounded on site. There is no indication where the remaining wastes from the site were disposed.

#### **2.2.2 Waste-Water Disposal**

Up until sometime in the 1930s, Dead Creek flowed through the property now occupied by Solutia Inc.'s William G. Krummrich (WGK) plant. In the 1930s, the Village of Sauget sewer system was installed. Prior to this installation, industrial process waste water from many of the East St. Louis and Sauget Industries flowed directly into Dead Creek. Sometime in the 1930s, Monsanto filled in the portion of Dead Creek located on its property. Storm water

continued to flow off the property into Dead Creek via a 36-inch diameter culvert under the railroad tracks at the south side of the property.

In 1932, the first public system of sewers was designed for the Village. The new sewers were constructed in 1932 and 1933. This included a 24-inch sewer north of Dead Creek running east to west. It also included an 18-inch sewer line that flowed from Route 3 eastward into Dead Creek. The 18-inch line served Midwest Rubber and possibly Darling Fertilizer. It handled both storm water and process water. It may have also carried sanitary and commercial waste to Dead Creek.

Sometime between 1939 and 1943, the Village took over maintenance and control of the 36-inch culvert pipe. The Village also installed Manhole 24 in the 24-inch sewer line at the north end of Dead Creek and ran the 36-inch culvert pipe into this manhole. By connecting the 36-inch pipe to the sewer system, the pipe could act as a conduit for water in the section of Dead Creek south of WGK to flow north into the sewer, and during times of overload on the sewer, the pipe would act as a conduit of sewer backflow into Dead Creek. At about this same time, Dead Creek was blocked at Judith Lane to function as a surge pond for the Village of Sauget sewer system. It can be assumed that this project, which in effect incorporated Dead Creek into the Village sewer system, was paid for, at least in part, by federal funding received by the Village for expansion of the sewer system because of war time industrial development.

In 1935, the creek was dredged between Monsanto's plant and Queeny Avenue. Dredged material was deposited along the east bank. Such dredging may have occurred more than one time.

In 1951, additional sewers along Mississippi Avenue were constructed. At this time, the 18-inch overflow line from Mississippi Avenue was connected to the Village sewer system so that normally only storm water would be discharged to Dead Creek. The industrial waste water

was discharged northward and stayed in the Village sewer system. The 18-inch line was still able to act as an overflow, however, for the rest of the system.

Cerro's effluent discharged through eight pipes directly into Dead Creek Segment A until 1966 when an interceptor line along Dead Creek was constructed for the purpose of discharging Cerro's waste water into the Village sewer system. An interceptor box was constructed during the Cerro sewer work. It was designed to allow the overflow of waste water from Manhole 24 to Dead Creek to continue. Even after the interceptor line was installed, it is possible that unidentified sewer discharges from Cerro entered the creek through the direct discharge pipes and through the Cerro connection to the Village sewer.

The amount of sewer discharges from area industries gradually decreased over the years. In 1966, various industries started to implement process changes that reduced the quantity of waste water discharged into the sewer. After a 42-inch sewer was constructed by Monsanto in the 1980s, overflows into Dead Creek likely occurred only during significant rainfall events. After 1984, increased sewer capacity further reduced the frequency of overflows to Dead Creek.

In addition to the 18-inch overflow line that ran from Mississippi Avenue east to Dead Creek Segment B, there were two sewer overflow lines that entered CS-A on the east side. These two overflow lines are in addition to the junction box at the north end of the Creek. One outfall was on the north end of CS-A. The other line ran west from the 8-inch north-south line along Queeny Avenue to Dead Creek. This line was basically residential but could also have been a source of industrial discharges.

Based on the above description of the history of the use of Dead Creek as part of the Sauget Village sewer system, it is evident that any industry discharging waste waters into the sewer is a suspect source of contamination in Dead Creek and Site I because of the disposal of dredged material from the creek onto Site I.

The following descriptions give additional information on the industrial discharges into the Village sewer system:

**Amax Zinc** The waste water discharged from the plant contained zinc, copper, iron, cadmium, magnesium, and PCBs. Waste water was directly discharged into Dead Creek at least until 1932, and likely continued for some time after that.

**Chemical Warfare Service** Spills and leaks at the plant were washed into the plant sewer which was connected to the Village sewer. Because of government confidentiality restrictions, it has been difficult to identify possible contaminants from this source.

**Cerro Copper** Cerro's waste water was known to contain the following contaminants: arsenic, cadmium, copper, nickel, zinc, antimony, beryllium, lead, silver, chromium, oil and grease, chloroform, 1,1,1-trichloroethane, trichloroethene, methylene chloride, toluene, xylene, acetone, naphthalene, and phenanthrene.

**Darling Fertilizer** The waste water from the plant contained phosphorus and nitrogen.

**Edwin Cooper & Company (now Ethyl)** Edwin Cooper and Company's discharges included acid and oil.

**Midwest Rubber** Midwest discharged waste directly into the creek through an effluent pipe into CS-B. Waste water would have contained pine tars, naphthalene, metals, PCBs and other waste oil. In 1971, sampling found rubber particles in the discharges as well as zinc. During sampling of waste waters of many Sauget area industries in 1971, it was found that Midwest's waste-water flow contained 9 parts per billion (ppb) PCBs.



**ExxonMobil** Prior to 1932, when the sewer was installed, Mobil discharged directly into Dead Creek. Waste water was discharged daily into the Village sewer system plant when the refinery was in operation up to 1970, then intermittently when the fuels terminal was in operation. The waste water was likely a combination of petroleum process water after separation, cooling water and storm water. Mobil's releases to the Village sewer ran down the "south trunk" which was the line that ran directly to the north of CS-A. A May 6, 1982 USEPA memo states that Mobil was one of many industries discharging wastes into Dead Creek. Contaminants in Mobil's waste water included petroleum hydrocarbons, phenols, ammonia nitrogen, and PCBs.

**Monsanto** From 1917 to 1997, the Monsanto William G. Krummrich Plant in Sauget was engaged in the manufacture of various inorganic and organic chemicals including adipic acid, alkylbenzene, benzyl chloride, butyl benzyl chloride, calcium benzene sulfonate, caustic soda, chlorine, chlorinated cyanuric acid, chlorophenols, monochloroacetic acid, monochlorobenzene, 2,4-D, fatty acid chloride, muriatic acid, nitric acid, 4-nitrodiphenylamine, ortho-dichlorobenzene, ortho-nitrophenol, PCBs, para-dichlorobenzene, para-nitroaniline, para-nitrochlorobenzene, pentachlorophenol, phenol, phosphoric acid, phosphorous trichloride, phosphorus pentasulfide, potassium phenyl acetate, potash, Santoflex<sup>®</sup>, Santomerse<sup>®</sup>, Santolube<sup>®</sup> 393, sulfuric acid, 2,4,5-tricresyl phosphate, and zinc chloride. The waste-water stream leaving the plant varied over the years, but may have contained the following: nitric acid, sulfuric acid, hydrochloric acid, chlorine, and chlorinated and nitrated aromatics.

**Rogers Cartage** Rogers Cartage owned and operated a fleet of tanker trucks. They hauled products for many companies in the Metropolitan St. Louis area. During Rogers operation in Area 1, it washed out tanker trucks that had been used to transport product and some wastes for many of the industries in Sauget and the surrounding area. Trucks were washed with caustic solution. Wash water was discharged to the ground and to the Village of Sauget sewer system.

Documentation in the field indicates that Rogers began using the sewer system in 1969. Rinse water was discharged into the Village sewer south trunk which then traveled to the sewer connection at the north end of Dead Creek. Also, there was a 12-inch sewer overflow line that was located at the Rogers Cartage property and discharged directly into Dead Creek Segment A near Queeny Avenue. It was installed sometime before 1965. This line was installed to allow relief of the northward traveling sewer line at times of heavy flow. Thus, this line would have caused truck washing waste water to discharge into Dead Creek. A Monsanto memo dated January 5, 1971 indicates that a significant quantity of PCBs in the Village sewer probably came from Roger's terminal.

The types of products Rogers hauled which were likely washed into the Village sewer including Dead Creek were: ortho-nitrochlorobenzene, monochlorobenzene, ortho-dichlorobenzene, sulfuric acid, maleic anhydride, phosphorus oxychloride, Therminol®, alkylbenzene, muriatic acid, monochloroacetic acid, aroclors, oleum, phosphorus oxychloride, phosphorus trichloride, phenol, petroleum and oil additives, zinc sulphate solution, sulfuric acid, phenol, acetone, toluene, benzene, and xylene mixtures.

**Sauget & Company** Sauget & Company operated a landfill at Site I for a number of years. The IEPA has reported that waste from Site I would routinely overflow and leach into Dead Creek.

**Sterling Steel** Cooling water from electric furnaces, compressors and air conditioning was discharged into the 24-inch sewer line at the north end of Dead Creek. PCB-containing materials were commonly used in casting facilities for fire prevention.

**Waggoner** Waggoner started operations on Site L in 1964. Waggoner owned/operated approximately 23 stainless steel trucks and a couple of rubber-lined trucks. They washed their trucks at Site L and drained the tank washings into Dead Creek. In addition, floor drains from the building flowed directly into Dead Creek. In the June 14, 1965 meeting minutes for the

Monsanto Village Plant Managers, the statement is made that Waggoner should be persuaded to cease dumping chemicals into Dead Creek. In an August 5, 1971 memorandum, the IEPA states that tanker trucks labeled as corrosive were apparently discharging their contents to Dead Creek near Queeny Avenue. The Agency notified the company of the discharge, and Waggoner responded that the discharges had been eliminated. After the IEPA required that discharges to CS-A cease, Waggoner excavated a pit which was used by Waggoner until 1974 when the company was sold to Ruan.

In 1973, the IEPA visited Waggoner and found that a hole had been excavated nearby into which the tanker truck wash water discharged. Use of a second pit appears to have begun in 1973. According to an IEPA memorandum drafted by Mr. Tim Murphy (1992 to USEPA), these pits were designed to overflow into Dead Creek.

Ruan reportedly continued using the pit until 1978. The IEPA estimated that between 1971 and 1978, 164,000 gallons of wash water were disposed in the pit. The pit was not lined and consisted of medium to coarse-grained sand.

The following materials were hauled by Waggoner and thus were likely washed into Dead Creek as rinsate from the truck washings: phosphorous trichloride, phosphorous oxychloride, biphenyl, aroclors, pyranols, phenol, alkylbenzene, petroleum additives, chloryl acetyl chloride, muriatic acid, monochloroacetic acid, sulfuric acid, chlorosulfuric acid, Santolube<sup>®</sup>, chlorosufonic acid, muriatic acid, sulfuric acid, oleum, plasticizers, caustic metal cleaners, oil additives, phosphoric acid, and Phostri (commercial name).

## **2.3 Removal and Remedial Actions**

### **2.3.1 Creek Segment A Remedial Action**

This northernmost segment of creek originally consisted of two holding ponds which were periodically dredged. On several occasions, CS-A was dredged and contaminated sediments were disposed onto adjacent Site I. Remediation work was conducted by Cerro Copper on

CS-A in 1990 and 1991 under an IEPA-approved plan. Approximately 27,500 tons of contaminated sediments were removed from depths of 10 to 15 feet below grade and transported to RCRA and TSCA permitted facilities (Waste Management Landfill in Emelle, Alabama). Subsequent to the installation of an HDPE vapor barrier, CS-A was filled and covered with crushed gravel. A portion of CS-A is now used for controlled-access truck parking. Land use surrounding CS-A is industrial. Since Segment A was remediated under an Agreement with the IEPA, no additional remedial or removal actions are planned.

### **2.3.2 Creek Segment B Removal Action**

Creek Segment B, and Site G, were fenced in 1988 pursuant to a USEPA CERCLA removal action that was funded by several potentially responsible parties (PRPs) including Monsanto.

### **2.3.3 Site G Removal Action**

The USEPA conducted a CERCLA removal action at Site G in 1995. This removal action involved the excavation of PCB, organics, metals and dioxin impacted soils on and surrounding Site G; solidification of open oil pits on the site; and covering part of the site with a clean soil cap approximately 18 to 24-inches thick. Site G is vegetated, enclosed by a fence and is not currently being used.

### **2.3.4 Dead Creek Culvert Replacement Removal Action**

The USEPA issued a UAO on June 21, 1999 requiring replacement of Dead Creek culverts to reduce the imminent threat that would result from Dead Creek flooding. Solutia's response to the UAO was three-fold:

- 1) Hydraulic modeling of the watershed was performed to determine the effect of replacing all of the culverts on Dead Creek to current design standards. This modeling indicated that the potential for flooding would not be reduced if the culverts were replaced. Bank elevations in some portions of the creek would still be lower than the 100-year flood level even if water could flow freely from upstream to downstream. Even though culvert replacement would not prevent

flooding in the watershed, Solutia proposed replacing culverts at Cargill Road and the Terminal Railroad embankment because this action would produce the greatest reduction in flood elevations. Replacement of these culverts is complete;

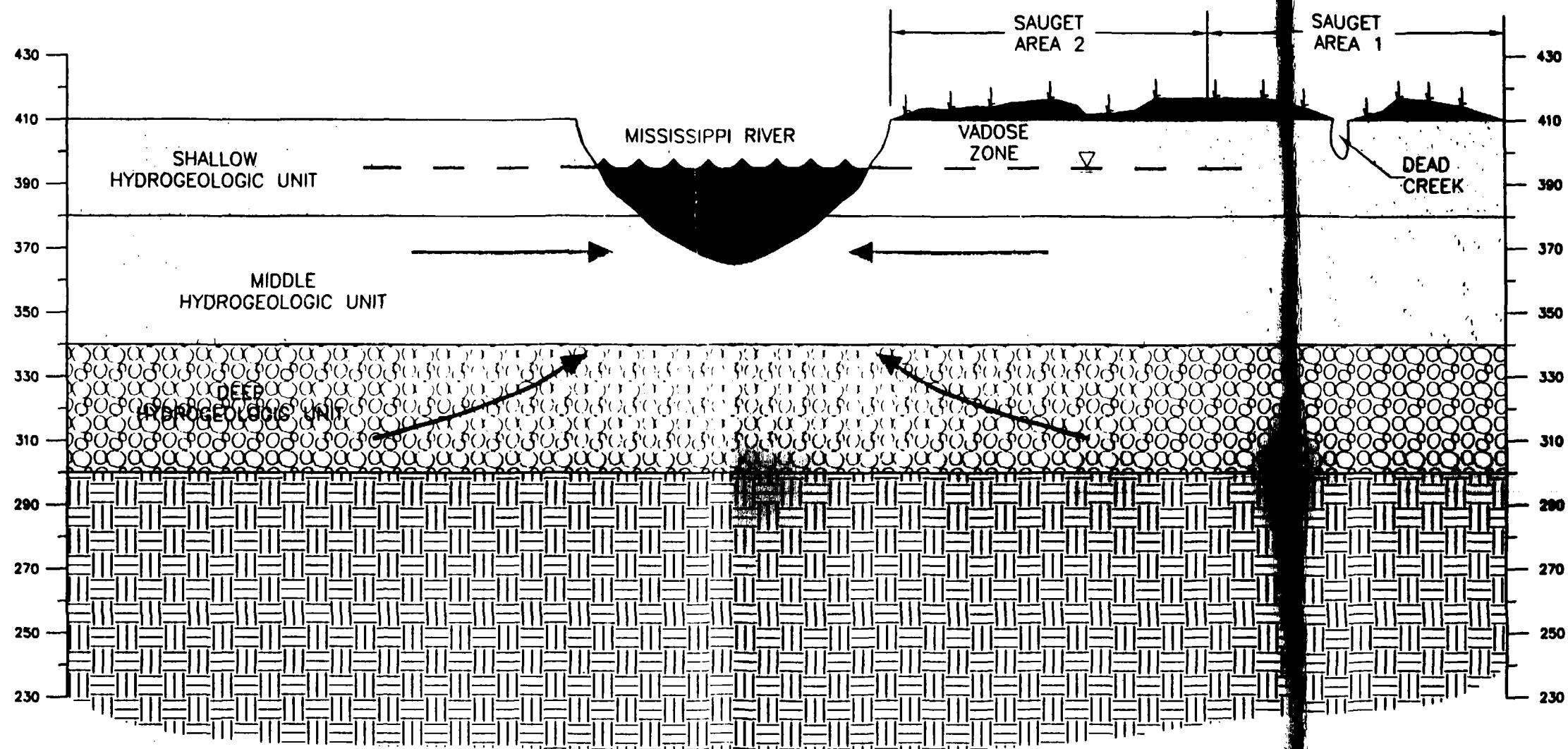
- 2) Initiation of a request for UAO modification to deal directly with the cause of the potential imminent threat cited in the June 21, 1999 UAO, i.e., the impacted sediments in Dead Creek. Rather than modifying the original UAO, the Agency issued a UAO on May 31, 2000 requiring Solutia to remove sediments from Creek Segments B, C, D and E and transfer them to an on-Site containment cell. The Time-Critical Removal Action Work Plan was submitted on June 30, 2000 as the first action required under the May 31, 2000 UAO. Command post construction was completed in 2000, and installation of the sediment dewatering system was completed in January, 2001.
- 3) Facilitation of studies and provision of assistance in obtaining public funding that would allow the Village of Cahokia to address the flooding and water management problems in the Dead Creek watershed. Public funding of \$300,000 was obtained for the Village of Cahokia to perform a flood study of Dead Creek. The Village is in the process of completing the applications necessary for disbursement of these monies by the Illinois Department of Commerce and Community Affairs.

#### **2.3.5 CS-B, C, D, E and F Sediment Removal Action**

As discussed above, the USEPA issued a UAO on May 31, 2000 for a Time-Critical Removal Action of sediments in Creek Segment B, C, D and E, to eliminate potential risks associated with flooding and to eliminate adverse ecological impact. As required by the USEPA, sediments in CS-F between Route 157 (Camp Jackson Road) and the Terminal Railroad Association embankment were included in the sediment removal action. Specific requirements of the UAO are:

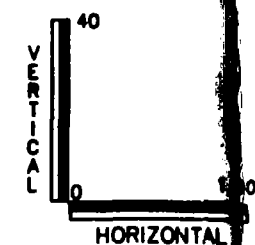
- Preparation of a Time Critical Removal Action Work Plan;

- Implementation of the Removal Action in accordance with the Work Plan to mitigate the threats posed by presence of contamination in Dead Creek Sediments and certain adjacent soils and their potential migration via overflow and flood waters from the Site;
- Removal of materials from CS-B (creek sediments, creek bed soils and flood plain soils); CS-C, D, E, and a portion of F (non-native creek sediments only); and Site M (pond sediments and pond bottom soils) in Sauget Area 1, while minimizing adverse impacts to area wetlands and habitat;
- Proper handling, dewatering, treatment and placement of such materials in an on-Site Containment Cell;
- A plan for management of Dead Creek storm water during implementation of the UAO;
- Sampling and analysis of areas where materials have been removed, for the purpose of defining remaining contamination;
- Placement of membrane liner material over CS-B and in all other excavated areas where, based on post-removal sample results, such liner is determined to be necessary; and
- Design and construction of a containment cell that will provide adequate protection to human health and the environment.



# **LEGEND**

- |  |   |  |                             |
|--|---|--|-----------------------------|
|  | FINE TO MEDIUM SAND (SM,SP)               |  | GROUND-WATER FLOW DIRECTION |
|  | MEDIUM TO COARSE SAND (SW)                |  | GROUND-WATER TABLE          |
|  | MEDIUM TO COARSE SAND AND GRAVEL (SW, GW) |  |                             |
|  | BEDROCK                                   |  |                             |



Title: <b>GENERALIZED CROSS SECTION SAUGET AREA 1</b>			
Prepared For:			
 ROUX ASSOCIATES, INC. <i>Geotechnical Consulting &amp; Management</i>		Compiled by: A.T. Prepared by: J.S.G. Project Mgr: R.J. File No: 0864RND8	Date: 02/01 Scale: AS SHOWN Office: TX Project: 0864RND8
			FIGURE <b>2-1</b>



SOURCE:  
U.S.G.S. CAHOKIA, IL-MO  
QUADRANGLE 1998  
7.5 MINUTE SERIES (TOPOGRAPHIC)

DRAWING DERIVED FROM URS  
FIGURE 1 "SITE LOCATION MAP"  
DATE JUNE 14, 2000



## SURROUNDING AREA USE SAUGET AREA 1

SAUGET AND CAHOKIA, ILLINOIS

Prepared For:

URS

**ROUX**

ROUX ASSOCIATES INC.  
Environmental Consulting  
& Management

Compiled by: L.W.R.

Prepared by: M.J.R.

Project Mgr: J.R.L.

Project: SAUGET AREA 1

Date: 8/20/01

State: N.Y.S.

Office: TX

Project: 00000000

FIGURE

2-2



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### **3.0 SUPPORT SAMPLING PLAN INVESTIGATION DESCRIPTION**

#### **3.1 Field Investigation Summary and Approach**

The January 21, 1999 AOC Scope of Work identified the additional Site characterization data required to define and evaluate removal action alternatives for the fill areas and Dead Creek and remedial alternatives for ground water. A Field Sampling Plan (FSP) was prepared by O'Brien & Gere Engineers, Inc. (OBG), on behalf of Solutia Inc., to implement the SSP. The FSP was designed to achieve the objectives of the SSP and the AOC. OBG was also responsible for the implementation of the FSP which commenced in September 1999 and was completed in April 2000. Ecological sampling was completed by Menzie-Cura & Associates, Inc. (Menzie-Cura) as described in the ERA Work Plan (SSP, Volume 1C). A Field Sampling Report (FSR) was prepared by OBG at the conclusion of the field work, and a final version of this document was submitted to the USEPA in September 2000. A separate Data Validation Report (DVR) containing the results of data validation reviews completed by OBG was submitted to the USEPA in August 2000.

An outline of the work completed in Area 1 is presented below:

##### **Fill Area Investigation**

- Nonmeasurement Data Acquisition
- Boundary Delineation Trenches
- Soil Gas Survey
- Waste Sampling
- Magnetometer Survey
- Buried Drum and Tank Identification

##### **Ground-Water Investigation**

- Ground-Water Sampling
  - Fill Area Ground-Water Sampling
  - Alluvial Aquifer Sampling
  - Downgradient Alluvial Aquifer Sampling
  - Alluvial Aquifer/Bedrock Interface Sampling

**Shallow Residential Area Ground-Water Sampling**

Time-Series Sampling

Domestic Well Sampling

Upgradient Ground-Water Sampling

Ground-Water Flow Direction

Aquifer Testing

**Soil Investigation**

Undeveloped Area Soil Sampling

Developed Area Soil Sampling

Background Soil Sampling

Grain Size Analysis

**Sediment Sampling Investigation**

Industry-Specific Sediment Sampling

Undeveloped Creek Sediments (CS-B and CS-F)

Developed Creek Sediments (CS-C, CS-D, and CS-E)

Borrow Pit Lake

Broad Scan Sediment Sampling

Dead Creek Segments, Borrow Pit Lake and Reference Areas

Site M

Old Prairie duPont Creek

**Surface-Water Investigation**

Dead Creek

Borrow Pit Lake and the Old Prairie duPont Creek

Reference Areas 1 and 2

Site M

**Air Sampling**

Upwind Air Samples

Downwind Air Samples

**Ecological Assessment**

Benthic Invertebrates

Warm Water Fish Species

Aquatic Birds

Great Blue Heron

Mallard Duck

Bald Eagle

Aquatic Mammals

River Otter

Raccoon

Muskrat

Soil Invertebrates

**Treatability Pilot Studies**

On-Site Thermal Desorption

Off-Site Incineration

Leachate Treatability Testing

Quality assurance and quality control (QA/QC) samples collected during the sampling programs generally consisted of the following:

- One duplicate per 10, or fraction of 10, environmental samples collected;
- One matrix spike/matrix spike duplicate (MS/MSD) per 20, or fraction of 20, environmental samples collected or one MS/MSD every three working days, whichever was sooner;
- One environmental blank (or field blank) per 10, or fraction of 10, environmental samples collected unless dedicated or disposable sampling equipment was used to collect samples; and
- One trip blank per sample cooler containing environmental samples for VOC analysis.

A summary of chemical analyses completed as part of the SSP is provided on Table 3-1 at the end of this section. Seven hundred forty-eight media samples and 328 QA/QC samples were collected resulting in 6,635 chemical analyses. The subsections below summarize these data collection activities. For more detailed information concerning the sampling procedures, locations, and supporting documentation, refer to the FSR and the Menzie-Cura Ecological Risk Assessment Report submitted to the USEPA in January 2001.

### **3.2 Fill Area Investigation**

Prior to performing any environmental sampling at the fill areas, several tasks were performed to ensure that the areas were adequately delineated. This work included viewing aerial photographs, performing elevation surveys at the sites, reviewing topographic maps, and installing boundary test trenches. Details and supporting information concerning these tasks are available in Volume 1 of the FSR in the Section titled Nonmeasurement Data Acquisition. The locations of the test trenches at Sites G, H, I, L, and N are shown on Figures 3-1 through 3-5. After the Fill Areas were delineated, the following investigations were performed: soil gas survey, waste sampling, magnetometer survey, and buried drum and tank identification.

#### **3.2.1 Soil Gas Survey**

A soil gas survey was conducted at Sites G, H, I, L, and N using a shallow soil probe (five feet) and on-site analysis of collected vapors for VOCs. Soil gas samples were collected at an approximate frequency of one sample per acre. Each Fill Area was divided into grids with 200 feet by 200 feet spacings. Each sample was collected at the approximate center point of the grid cell using the following grids:

Site	Grid Size	Grid Spacing	No. of Samples
G	400' x 600'	200' x 200'	6
H	400' x 800'	200' x 200'	8
I	400' x 1,200'	200' x 200'	12
L	200' x 200'	200' x 200'	1
N	300' x 300'	200' x 200'	2
<b>Total Number of Samples</b>			<b>29</b>

When detectable concentrations of VOCs were detected in the Fill Area soil gas samples, the survey was extended beyond the grid boundaries. A total of 36 additional soil gas samples was collected perpendicular to the Fill Area grid cells (see table below). Soil gas samples were collected at 100-foot intervals (0, 100 and 200 feet from the edge of the grid cell) along four 200-foot-long transects; one transect perpendicular to each side of the grid cell.

Site	No. of Transects	No. of Samples
G	2	6
H	4	10
I	3	10
L	4	10
N	0	0
Total Number of Samples		36

Soil gas sample locations are depicted in Figures 3-6 through 3-10 for the five individual sites. The field logs, notes, and graphs that were developed during the soil gas survey program are provided in the FSR (Volume 1).

### 3.2.2 Waste Sampling

The following tasks were performed to characterize the fill material within the fill areas:

- Five soil borings were advanced at each of Sites G, H, I, L, and N using conventional hollow-stem auger drilling methods.
- Continuous soil samples were collected from the ground surface to approximately two feet below the bottom of the fill material in four of the five borings per site. These borings are referred to as "sample borings" in this document and in the FSR.
- In one of five soil borings per site, native soil below the fill material was field screened for VOCs using a photoionization detector (PID). This screening was conducted to a depth of 10 to 15 feet below the fill material. These borings are referred to as "screen borings" in this document and in the FSR.
- A discrete surface soil sample, from 0 to 0.5 feet, was collected at the four "sample boring" locations for each of Sites G, H, I, L, and N prior to installation of the

borings. The surface soil sample analyses are used to characterize present site conditions and complete the HHRA and the ERA for this project.

- One composite waste sample was collected at each "sample boring" location (except at location B2 on Site H) and analyzed for waste characteristics. Visual observations (discoloration, presence of foreign objects, etc.) and PID readings were used to identify whether waste was present in a continuous boring sample.

A copy of the boring logs, field notes, color digital photographs, and more detailed descriptions of work performed in the field are presented in the FSR (Volume 1, Section 3.3).

### **3.2.3 Magnetometer Survey**

Magnetometer surveys were conducted at Sites G, H, I, L, and N to identify anomalies indicative of drum disposal or buried tanks. The following tasks were performed:

- Magnetometer measurements were made at locations determined by superimposing an approximate 50-feet by 50-feet grid on the Fill Areas. The magnetometer survey was conducted with a Geometrics 856 Total Field Magnetometer. Operation of equipment and calibration of instruments were in accordance with the manufacturer's recommended field procedure and application manual.
- Magnetometer measurement points were located in the field using known points such as buildings, roads, or other fixed features or by using Global Positioning System (GPS).

The total number of measurements completed per Site is presented below:

Site	Measurements
G	77
H	106
I	255
L	19
N	86
<b>Total Number of Measurements</b>	<b>543</b>

After the surveys were completed, maps were developed which showed the distribution of magnetic field strength over the five sites. These maps were compared with the observed field conditions (including the location of known interfering objects such as vehicles, overhead power lines, and surface debris). By comparison, those magnetic anomalies which could not be explained by observed site conditions were presumed to be the result of buried metallic subsurface material (drums, tanks, debris, etc.). These data were used to strategically place the test confirmation trenches discussed in the next section.

For additional information pertaining to the magnetometer survey, equipment used, and procedures, refer to the FSR (Volume 1, Section 3.4).

#### **3.2.4 Buried Drum and Tank Identification**

To evaluate whether the anomalies detected during the magnetometer survey are associated with buried drums or tanks, test trenches were dug at anomalies that coincided with the following findings:

- Elevated ground-water concentrations as identified by the 1998 E&E Data Report;
- VOC detections from the soil gas survey;
- Magnetic anomalies identified by the 1988 E&E geophysical survey; and
- Areas of drum or tank disposal identified during historical aerial photograph analysis of Fill Area boundaries.

One test trench each was excavated at Sites G, H, L, and N. Two test trenches were excavated at Site I. The test trenching was conducted as described below:

- Test trenches were advanced until evidence as to the source of the anomaly was located.
- Spoils from the trenching operation were placed on polyethylene sheeting, and the stockpile was sloped to allow any excavated liquids to drain back to the trench.
- At the completion of the excavation, the spoils were returned to the excavation and the site was restored.



For additional information pertaining to the trenching operation and copies of field logs, records, and color digital photographs, refer to the FSR (Volume 1, Section 3.5).

### **3.3 Ground-Water Investigation**

The ground-water investigation conducted at the Site included ground-water sampling, time series analyses, and aquifer (slug) testing. Ground-water samples were collected from three different zones in the alluvial aquifer, the alluvial aquifer/bedrock interface, and domestic wells in the Area 1 vicinity. These activities are described in the following subsections. Details and supporting information concerning monitor well installations that were conducted during the ground-water investigation are included in Volume 1 of the FSR.

#### **3.3.1 Ground-Water Sampling**

Ground water was sampled from existing monitor wells, newly installed monitor wells, and domestic wells in the Sauget Area 1 vicinity. Furthermore, other ground-water samples were collected via push sampling technology using Geoprobe® and Hydropunch® equipment. The areas where ground-water samples were collected included the Fill Areas, the alluvial aquifer, the alluvial aquifer/bedrock interface, residential areas, and upgradient locations. The procedures that were followed and corresponding documentation pertaining to the ground-water sampling are provided in the FSR (Volumes 1, 2, 3, and 4). The following is a summary of the work that was performed in each area and a list of the wells that were sampled.

##### **3.3.1.1 Fill Area Ground-Water Sampling**

Ground-water concentrations at the Fill Areas were evaluated by performing the following tasks:

- Sampled the existing wells installed by E&E. These wells were EE-01 through EE-05, EE-12 through EE-15, EE-20, and EEG-101 through EEG-112.
- Collected shallow background ground-water samples from wells EE-04, EE-20, and EEG-108. Each of these wells were located, checked for the presence of non-aqueous

phase liquids (NAPLs), plumbed for depth and matched against construction records, redeveloped to remove accumulated fine-grained materials and promote ground water entry into the well, and sampled to provide data on current ground-water conditions at the fill areas.

A summary of the wells sampled and the corresponding fill areas that the samples were collected for is provided below:

Site	Fill Area or Background Well	Screen Depth (Feet Below Ground Surface)
G	EE-05	18-23
	EEG-101	18-23
	EEG-102	16.5-21.5
	EEG-104	19-24
	EEG-106	18-23
	EEG-107	23-28
	EEG-111	No Construction Log
	EEG-112	21-26
H	EE-01	28-33
	EE-02**	18-23
	EE-03	27-32
	EEG-110	18-23
	EE-04***	18-23
I	EE-12*	28-33
	EE-13*	23-29
	EE-14**	32.5-37.5
	EE-15*	24-29
	EE-20***	23-28
L	EEG-103**	16.5-21.5
	EEG-105*	No Construction Log
	EEG-109	17.5-22.5
	EEG-108***	24-29
*	Well no longer exists	
**	Well exists, but can not be sampled	
***	Shallow ground-water background well	

Nineteen ground-water samples were collected from the wells and locations described above. For wells that no longer exist or could not be sampled, samples were collected by advancing a geoprobe and obtaining a ground-water sample from the same depth interval. Each of the samples was analyzed for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

A discussion of the field procedures that were used while collecting these samples is provided in Section 3.7.3 of the FSR (Volume 1) which also contains all of the corresponding documentation (chain-of-custody forms, logs, meeting records, etc.).

#### **3.3.1.2 Alluvial Aquifer Sampling**

One alluvial aquifer saturated-thickness sampling station was located within the shallow ground-water high concentration plume estimated by E&E at Site H and at Site I. Ground-water samples were collected within these plumes in order to evaluate the extent of organic and inorganic constituents underlying Sites H and I.

Telescoping surface casing was installed to approximate depths of five feet and 20 feet below the fill material at each site in order to minimize carry-down of Site-related constituents during ground-water sample collection. The casing was grouted from the bottom up after completion of sampling.

Ground-water samples were collected every 10 feet from the bottom of the surface casing to bedrock, which were approximately 48 and 104 feet below existing grade, respectively, at Site I and approximately 44 and 105 feet below existing grade, respectively, at Site H.

Eleven ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the alluvial aquifer ground-water sampling, refer to Section 3.8 (Volume 2) of the FSR.

#### **3.3.1.3 Downgradient Alluvial Aquifer Sampling**

The ground-water quality downgradient of the fill areas was investigated by collecting ground-water samples along transects downgradient and to the southwest of Sites G and I. A summary of this sampling program is provided in the following paragraphs.

##### *Downgradient of Site G*

- The horizontal and vertical extent of organic and inorganic constituents downgradient from Site G and toward the Mississippi River were evaluated by collecting samples at three sampling stations located along a transect between the maximum shallow ground-water concentrations at Site G and Illinois Route 3.
- Ground-water samples were collected every 10 feet from the water table to bedrock using push sampling technologies as mentioned in the previous section.

Thirty-one ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

##### *Downgradient of Site I*

- The horizontal and vertical extent of organic and inorganic constituents downgradient from Site I and toward the Mississippi River were evaluated by collecting samples at three sampling stations located along a transect between the maximum shallow ground-water concentrations at Site I and Illinois Route 3.
- Ground-water samples were collected every 10 feet from the water table to bedrock.

Twenty-eight ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

*Areas Southwest of Sites G and I*

- The horizontal and vertical extent of organic and inorganic constituents cross-gradient from these sites in a southwesterly direction were evaluated by collecting samples at three sampling stations located along a transect between the maximum shallow ground-water concentrations at Site G and Judith Lane.
- Ground-water samples were collected every 10 feet from the water table to bedrock.

Thirty samples were collected and analyzed in an off-Site laboratory for the following constituents: cyanide, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

The presence or absence of dioxin in ground water downgradient from Sites G and I was evaluated by analyzing samples from the deep, middle, and shallow hydrogeologic units of the alluvial aquifer at each of the three sampling stations downgradient of Site G; each of the three sampling stations downgradient of Site I; and each of the three sampling stations southwest of Sites G and I. Twenty-seven ground-water samples was collected and analyzed for dioxins via USEPA Method 8290. Samples were collected concurrently with the other downgradient samples described above.

For discussion of the field procedures that were followed during sample collection and documentation related to the downgradient alluvial aquifer ground-water sampling, refer to Section 3.9 (Volume 2) of the FSR.

**3.3.1.4 Alluvial Aquifer/Bedrock Interface Sampling**

To evaluate the vertical extent of organic and inorganic constituents at the alluvial aquifer/bedrock interface, the following tasks were performed:

- Three wells were installed in the upper portion of the bedrock at the alluvial aquifer/bedrock interface at Sites G, H, and I.
- Locations for the wells were based on the shallow ground-water high concentration plume estimated by E&E. Telescoping surface casings were installed in order to minimize carry-down of Site-related constituents during well installation and to prevent vertical migration of Site-related constituents after completion.
- Bedrock was cored to a depth of 20 feet below the telescoping casing. Cores were digitally photographed in color against a scale and evaluated for porosity by examination in petrographic thin sections. A ground-water sample was collected from each core hole.

Three ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the ground-water sampling of the alluvial aquifer/bedrock interface, refer to Section 3.10 (Volume 2) of the FSR.

#### **3.3.1.5 Domestic Well Sampling**

Ground-water samples were collected from four non-potable use domestic wells on Judith Lane that could be used for irrigation purposes. Non-potable use domestic wells were sampled from the residences at 100 Judith Lane, 102 Judith Lane, 104 Judith Lane, and 109 Judith Lane. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the domestic well sampling, refer to Section 3.13 (Volume 3) of the FSR.

#### **3.3.1.6 Shallow Residential Area Ground-Water Sampling**

The following tasks were performed to evaluate if Site-related constituents are present between Dead Creek and the non-potable use domestic wells described in the previous section:

- Shallow ground-water samples were collected at two sampling stations; one located at the end of Walnut Street, and the other located on the east bank of Dead Creek at Judith Lane.
- Ground-water samples at each of the two locations were collected at the water table (approximately 15 feet below the ground surface) and at depths of 20 and 40 feet below ground surface which bracket the typical completion depths of domestic wells in Southern Illinois.

Six ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the shallow residential area ground-water sampling, refer to Section 3.11 (Volume 3) of the FSR.

#### **3.3.1.7 Time-Series Sampling**

After collection and analysis of the shallow ground-water, vertical-profile samples at Walnut Street and Judith Lane (previous section), one MicroWell<sup>®</sup> was installed at each sampling station with its screened interval in the zone of highest detected constituent concentrations (approximately 40 feet below ground surface). These wells were continuously pumped and samples were collected. Time-series samples were collected at approximately 0, 12, and 24 hours after the start of pumping in order to stress the saturated zone during sampling and evaluate constituent concentration trends.

Six ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the time series ground-water sampling, refer to Section 3.12 (Volume 3) of the FSR.

#### **3.3.1.8 Upgradient Ground-Water Sampling**

Existing wells EE-20, EE-04, and EEG-108 were used as background (upgradient) ground-water sampling locations. These wells, which are screened at depths of 23 to 28 feet, 18 to 23 feet, and 24 to 29 feet respectively, were redeveloped using the procedures stated in the FSR (Section 3.16). In addition, ground-water samples were collected at depths of 60 and 100 feet below grade surface at each of these locations using push sampling technology (Geoprobe®) and low-flow sampling techniques. A sampling depth of 60 feet is approximately the midpoint between the screened interval of the existing shallow wells and the bottom of the aquifer, which was anticipated to be approximately 100 feet deep. At one of the proposed sampling locations, access permission could not be obtained from the property owner, and a substitute location was selected (EE-04-SUB).

Nine ground-water samples were collected. These samples were analyzed in an off-Site laboratory for the following constituents: cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the sampling of upgradient ground-water wells, refer to Section 3.16 (Volume 4) of the FSR.



### **3.3.2 Ground-Water Flow Direction**

Ground-water flow direction in Area 1 was evaluated by installing nine piezometer clusters. Each cluster contained three small-diameter piezometers screened in the shallow hydrogeologic unit (0-30 feet deep), middle hydrogeologic unit (30-70 feet deep), and the deep hydrogeologic unit (greater than 70 feet deep). Each of these wells was gauged quarterly to determine the potentiometric surface in each zone.

### **3.3.3 Aquifer Testing**

Slug tests were performed to determine the hydraulic coefficients for the aquifer system at Area 1. The procedures for performing these tests are described in the SSP. The purpose for conducting slug tests was to collect data to aid in evaluating ground-water transport characteristics and possible remedial alternatives.

To conduct the slug tests, three two-inch-diameter, stainless-steel piezometers were installed adjacent to each fill area (Sites G, H, I, L, and N). The three wells in each area were screened in the shallow, middle, and deep hydrogeologic units. Fifteen slug tests were performed (five tests in each of the three zones). The data collected during these tests were recorded with a Hermit® Data logger. The data were subsequently plotted on a semi-log plot and analyzed using the Bouwer-Rice method (for unconfined aquifers).

For a description of the procedures that were followed during the aquifer testing program and for supporting documentation, refer to Section 3.14 of the FSR (Volume 3).

### **3.4 Soil Investigation**

Soils samples were collected in both undeveloped and developed areas that are susceptible to flooding and deposition of wind-blown dust. Floodplain soil sampling was conducted in an area bounded by Queeny Avenue on the north, Falling Springs Road on the east, Illinois Route 157 (Camp Jackson Road) on the south, and Illinois Route 3 (Mississippi Avenue) on the west. This area is where storm water backs up at road crossings during heavy rains and

where PCBs are known to occur in creek sediments. This area also included most of the residential development in Sauget Area 1.

Information from the soil sampling program is used to evaluate the extent of migration due to overbank flooding and wind-blown dust deposition. In addition, surface and subsurface soil information are used in the HHRA and the ERA.

#### **3.4.1 Undeveloped Area Soil Sampling**

Floodplain soil samples were collected at evenly spaced intervals up to 200 feet on seven transects in the undeveloped areas, for a total of 45 sampling stations. Surface (0 to 0.5 feet below ground surface) and subsurface (three to six feet) samples were collected to evaluate the extent of migration via surface water (overbank flow) and air (wind blown dust) pathways. The surface and subsurface soils were analyzed for two different sets of parameters as discussed below. Sampling transects were placed in undeveloped areas adjacent to developed areas (Section 3.4.2) to allow ready access for sampling. The transect number versus the number of sampling stations and number of soil samples collected in the undeveloped areas are provided in the table below:

<b>Transect</b>	<b>Number of Sampling Stations</b>	<b>Number of Surface and subsurface Samples</b>
1	7	7
2	6	6
3	7	7
4	7	7
5	6	6
6	5	5
7	7	7
<b>Total</b>	<b>45</b>	<b>45</b>

The soil samples collected at the surface were analyzed for the following parameters: bulk density, cyanide, herbicides, mercury, metals, moisture content, PCBs, pesticides, pH, specific gravity, SVOCs, and VOCs. The soil samples collected in the subsurface were analyzed for cyanide, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

Twenty percent of the surface soil samples were also analyzed for dioxins to provide data for the HHRA and the ERA. The total number of soil samples collected for dioxin analysis was 18 (nine surface soil samples, and nine subsurface soil samples). For more information pertaining to the procedures that were followed during sample collection, refer to Section 3.17 of the FSR (Volume 4).

### **3.4.2 Developed Area Soil Sampling**

Surface and subsurface soil samples were collected at 20 locations adjacent to the seven transects identified in Section 3.4.1. Three soil samples (both surface and subsurface) were collected at residences adjacent to transects 1 through 6, and two soil samples (both surface and subsurface) were collected adjacent to transect 7. Visual observation (discoloration) and field PID readings were recorded for the samples.

The soil samples collected at the surface were analyzed for the following parameters: bulk density, cyanide, herbicides, mercury, metals, moisture content, PCBs, pesticides, pH, specific gravity, SVOCs, and VOCs. The soil samples collected in the subsurface were analyzed for cyanide, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs.

One hundred percent of the surface soil samples and 20% of the subsurface soil samples were also analyzed for dioxin to provide data for the HHRA and ERA. The total number of soil samples that were collected for dioxin analysis was 24 (20 surface samples, and four subsurface samples). For more information pertaining to the procedures that were followed during sample collection, refer to Section 3.18 of the FSR (Volume 4).

### **3.4.3 Background Soil Sampling**

Background soil samples were collected near the locations of the wells that were sampled for ground-water background (upgradient) data. These wells are identified as wells EE-20, EE-04, and EEG-108, and are located on the east sides of Sites I, H, and L, respectively. Background soil samples were collected from depths of 0 to 0.5 feet and three to six feet below ground surface at the three locations. Thus, six total samples were collected and were analyzed for the following parameters: cyanide, herbicides, mercury, metals, PCBs, dioxins, pesticides, SVOCs, and VOCs. In addition, surface soil samples were analyzed for bulk density, moisture content, pH and specific gravity. For more information pertaining to the procedures that were followed during sample collection, refer to Section 3.19 of the FSR (Volume 4).

### **3.4.4 Grain-Size Analysis**

One soil probe or boring was completed adjacent to each fill area (Sites G, H, I, L, and N) to identify the grain size of the aquifer matrix. Soil samples were collected from the upper, intermediate, and lower aquifer zones via Geoprobe® or other suitable push technology except at Site N. Samples were collected using a hollow-stem auger and split spoon apparatus adjacent to Site N as described in the FSR (Section 3.15.4.1). No QA/QC samples were collected since grain size analysis is a physical test. For more information concerning the field procedures that were followed and supporting documentation, refer to Section 3.15 of the FSR (Volume 4).

### **3.5 Sediment Sampling Investigation**

Vertically-integrated sediment core samples were collected in each segment of Dead Creek that runs through Area 1 (except CS-A, see section 2.3.1.) plus three additional contiguous areas (Site M, Borrow Pit Lake, and Old Prairie duPont Creek). These samples were collected to evaluate the downstream extent of Site- and industry-specific constituents and to provide information for use in the HHRA and the ERA. The sediment samples were analyzed for two separate sets of parameters - industry-specific constituents and broad-scan

constituents. The industry-specific constituents were analyzed to evaluate the distribution of constituents related to industrial sources located at the upstream end of Dead Creek. The broad-scan constituents were analyzed to evaluate the downstream extent of target compounds on the list/target analyte list (TCL/TAL) constituents. The following subsections provide an overview of the sampling efforts.

### **3.5.1 Industry-Specific Sediment Sampling**

The following section pertains to the sediment samples that were collected in Area 1 for the purpose of industry-specific analyses. This section provides a brief description of the sampling procedures and is divided into the different areas along Dead Creek where industry-specific samples were collected for analysis (undeveloped segments, developed segments, and Borrow Pit Lake). Sediment samples collected for the purpose of broad-scan constituent analyses are discussed in Section 3.5.2.

The industry-specific constituent parameter list is provided below:

Copper	USEPA Method 7211
Grain Size	ASTM D 422
PCBs	USEPA Method 680
Solids Content	USEPA Method SM2540G
TOC	USEPA Method 9060
TPH	USEPA Method 8015B
Zinc	USEPA Method 7951

#### **3.5.1.1 Undeveloped Creek Segments (CS-B and CS-F)**

In the undeveloped areas of Dead Creek (CS-B and CS-F), vertically integrated sediment core samples were collected as follows:

- Samples were collected at approximately 200-foot intervals (thus, one sampling station per 200 linear feet).

- Samples were collected in depositional areas at the thickest sediment profile following the procedures outlined in the FSR. The channel (or creek) cross section was surveyed at each sampling station, and sediment depth was measured at three locations perpendicular to the channel (channel center, halfway between channel center and right channel edge, and halfway between channel center and left channel edge).
- Samples were collected at 50 sample stations that were previously selected by Solutia and USEPA representatives.
- Each sample was analyzed for industry-specific constituents which were: copper, PCBs, total organic carbon (TOC), total petroleum hydrocarbons (TPH), and zinc. Grain size distribution and solids content analyses were also performed on the samples.

#### **3.5.1.2 Developed Creek Segments (CS-C, CS-D and CS-E)**

In the developed areas of Dead Creek (CS-C, CS-D, and CS-E), vertically integrated sediment core samples were collected as follows:

- Samples were collected at approximately 150-foot intervals (thus, one sampling station per 150 linear feet).
- Samples were collected in depositional areas at the thickest sediment profile and surveyed using the same procedure described above for the undeveloped segments.
- Samples were collected at 47 sample stations that were previously selected by Solutia and USEPA representatives.
- Each sample was analyzed for industry-specific constituents which were: copper, PCBs, TOC, TPH, and zinc. Grain size distribution and solids content analyses were also performed on the samples.

#### **3.5.1.3 Borrow Pit Lake**

Sediment samples were collected and analyzed in the Borrow Pit Lake as described below:

- Samples were collected at eight sampling stations on a 400-foot sampling interval.

- Sediment samples were collected using the same equipment and procedures as outlined in Section 3.20 of the FSR; however, cross-sections and sediment depth measurements were not performed in the Borrow Pit Lake.
- Eight samples were analyzed for the presence of industry-specific parameters including: copper, PCBs, TOC, TPH, and zinc. Grain size distribution and solids content analyses were also performed on the samples.

### **3.5.2 Broad-Scan Sediment Sampling**

The following subsections pertain to the sediment samples that were collected for the purpose of broad-scan analyses. The broad-scan analyses were completed to evaluate the extent of TCL/TAL constituents and to support the HHRA and the ERA. The areas where sediment samples were collected included the undeveloped Creek Segments, developed Creek Segments, Borrow Pit Lake, Site M, Old Prairie duPont Creek, and two reference locations.

The broad-scan parameter list is provided below:

Cyanide	USEPA Method 9010B
Dioxins	USEPA Method 8290
Grain Size	ASTM D 422
Herbicides	USEPA Method 8151A
Mercury	USEPA Method 7471A
Metals	USEPA Method 6010B
PCBs	USEPA Method 680
Pesticides	USEPA Method 8081A
Solids Content	USEPA Method SM2540G
SVOCs	USEPA Method 8270C
VOCs	USEPA Method 5035/8260B
TOC	USEPA Method 9060

### **3.5.2.1 Dead Creek Segments, Borrow Pit Lake and Reference Areas**

In support of the Ecological Assessment Sampling Plan, as described in the SSP, sediment samples were collected at the areas identified below:

- Creek Segment B – three sampling stations
- Site M – one sampling station
- Creek Segment C – three sampling stations
- Creek Segment D – three sampling stations
- Creek Segment E – three sampling stations
- Creek Segment F – three sampling stations (between Route 157 and Borrow Pit Lake)
- Borrow Pit Lake – three sampling stations
- Reference Area 1 – two sampling stations
- Reference Area 2 – two sampling stations

These locations were selected by Menzie-Cura because they were physically comparable to those in the Dead Creek watershed (in order to provide a basis for comparison with Dead Creek and Borrow Pit Lake) and because they were located away from the direct influence of industrial discharges, including major highways. The sediment samples collected for the Ecological Assessment were also collected to evaluate the extent of downstream migration of TCL/TAL constituents. These broad-scan analyses are intended to provide information for both the HHRA and ERA.

The procedures for collecting these samples were different than the procedure described in Section 3.2. These samples were collected using an Ekman grab sampler or by using stainless-steel trowels and spoons. For more information concerning these sampling procedures, refer to the Menzie-Cura Ecological Risk Assessment report.



### **3.5.2.2 Site M**

Site M was characterized by collecting four vertically-integrated sediment samples using the procedures described in Section 3.2. TCLP analyses were performed for dioxins, herbicides, mercury, metals, pesticides, SVOCs, and VOCs (per USEPA Method 5035). Analyses were also performed to determine total cyanide, TOC and total PCBs.

### **3.5.2.3 Old Prairie duPont Creek**

To evaluate the impact of the Dead Creek discharge on sediment quality in Old Prairie duPont Creek, one sample was collected upstream and one sample was collected downstream of the confluence of Dead Creek and Old Prairie duPont Creek. These samples were collected via the procedures described in the FSR, except an additional VOC sample was collected using EnCore® samplers per USEPA Method 5035. The location of the upstream sample in Old Prairie duPont Creek was collected at an appropriate distance from the confluence with Dead Creek so that possible previous effects of flooding and flow reversals would not affect the collection of the background sample. As reported in the 1996 Hazard Ranking System (HRS) package prepared by PRC Environmental Management, Inc. for USEPA Region V, a background sampling station was located 200 feet north (upstream) of the confluence of Dead Creek and Old Prairie duPont Creek. The sediment background sample was collected at this approximate location.

Samples were collected in depositional areas at the thickest sediment profile. Channel cross-sections were surveyed at each sampling station, and sediment depth was measured at three locations perpendicular to the channel (channel center, halfway between channel center and right channel edge, and halfway between channel center and left channel edge). Two sampling stations were identified. The samples were analyzed for cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, TOC, and VOCs (per USEPA Method 5035).

### **3.6 Surface-Water Investigation**

Surface-water samples were collected to evaluate the downstream extent of Site-related constituents and to provide information for use in the HHRA and the ERA. Surface-water samples were co-located with broad-scan sediment samples (Old Prairie duPont Creek sediment samples and Dead Creek ecological sediment samples). The surface-water samples were collected in the following manner:

- Surface-water samples were collected at the approximate upper, middle, and lower sections of each segment of Dead Creek to evaluate the downstream extent of Site-related constituents.
- Two surface-water samples were collected in Borrow Pit Lake upstream of the discharge of Dead Creek to assess the effect of backwater conditions and/or the contributions of other sources. One sample was collected upstream and one sample was collected downstream of the confluence of Dead Creek and Old Prairie duPont Creek.
- Two surface-water samples were collected at two sampling stations located at Reference Areas 1 and 2. Additionally, one sampling station was selected at Site M.
- Surface-water samples were collected at an approximate depth of 60 percent of the creek water column (measured from the top of the water column).
- Twenty surface-water samples were collected. Each sample was analyzed in an off-Site laboratory for the presence of the following constituents: cyanide, dioxins, fluoride, hardness, herbicides, mercury, metals, ortho-phosphate, PCBs, pesticides, pH, SVOCs, total dissolved solids (TDS), total phosphorous, total suspended solids (TSS), and VOCs.

For discussion of the field procedures that were followed during sample collection and documentation related to the surface-water sampling, refer to Section 3.21 (Volume 5) of the FSR.

### **3.7 Air Sampling**

Ambient air sample collection was performed to measure airborne levels of VOCs, SVOCs, PCBs, dioxin, and metals that may be emanating from the Site. An air sample collection and analytical test method was selected to measure airborne constituent levels over a 24-hour time period. A 24-hour sample duration was required to average the air emission differences that may occur from the daytime to nighttime cycle from on-Site and off-Site conditions and activities. Also, air sample collection locations were positioned at the Site to collect upwind and downwind samples for differentiation of constituents originating from the surrounding area and those originating from the Site.

*Volatile Organics* – Twenty-four-hour cumulative duration sorbent tube samples were collected over a one-day period using USEPA Method TO-1 sampling protocol (Appendix G of the 1999 FSP). Two upwind and two downwind sorbent tube samplers (two tubes each) were installed around Site G; and three upwind and six downwind sorbent tube samplers (two tubes each) were installed at Sites H, I, and L. Sampling locations were selected in the field with the concurrence of USEPA Region V or its designee. Thirteen air samples were collected for analysis of the presence of volatile organics.

*Semivolatile Organics, PCBs and Dioxins* – Twenty-four-hour cumulative duration polyurethane foam (PUF) samples were collected over a one-day period using USEPA Method TO-13, TO-4, and TO-9 sampling protocols (Appendix G of the 1999 FSP). Two upwind and two downwind PUF samplers were installed around Site G; and three upwind and six downwind PUF samplers were installed at Sites H, I, and L. Sampling locations were selected in the field with the concurrence of the USEPA or its designee. Thirteen air samples were collected for the analysis of dioxin (Method TO-9), PCBs (Method TO-4), and SVOCs (Method TO-13).

**Metals** – Twenty-four-hour cumulative duration PM 2.5 samples were collected over a one-day period using USEPA Method 6010B sampling protocol (Appendix G of the 1999 FSP). Two upwind and two downwind PM 2.5 samplers were installed around Site G; and three upwind and six downwind PM 2.5 samplers were installed at Sites H, I, and L. Sampling locations were selected in the field with the concurrence of the USEPA or its designee. Thirteen air samples were collected for the analysis of metals.

For more information concerning the air sampling procedures that were followed, or the supporting documentation, refer to Section 3.22 of the FSR (Volume 6).

### **3.8 Ecological Risk Assessment**

As outlined in Section 3.1 of this document, an Ecological Risk Assessment was performed at Sauget Area 1 by Menzie-Cura. Additional information concerning this assessment is provided in Appendix 1C of the SSP, and in Section 7.0 of this document.

### **3.9 Pilot Treatability Studies**

Pilot treatability tests were to be performed on waste area material, sediments, and leachate to evaluate specific remedial technologies identified in the AOC SOW. The sediments and waste area material were to be tested using both on-Site thermal desorption and off-Site incineration. However, the requirement to pilot test the creek sediments was eliminated after a UAO (see Section 2.2) requiring on-Site sediment removal was issued by the USEPA. Furthermore, a thermal desorption contractor could not be located in the United States who holds the RCRA and TSCA permits required to thermally treat the fill area materials containing dioxins and PCBs. Thus, the thermal treatment pilot testing program was reduced to evaluating the feasibility of incineration of fill area materials.

One composite organic waste sample was produced by mixing materials generated from one waste boring at each of the fill areas (Boring B3 on Site G, B3 on Site H, B2 on Site I, B4 on Site L, and B1 on Site N). Boring selection was based on PID readings and log descriptions

recorded during boring advancement. The composite sample from these borings was submitted to SafetyKleen in Coffeyville, Kansas for waste profiling, characterization, and to determine the feasibility of treatment through incineration (pilot testing). SafetyKleen is the only incinerator contractor located that possesses both RCRA and TSCA permits required to process the Site waste materials. After review of laboratory analysis of the composite sample, it was determined that high levels of metals (especially volatile metals such as arsenic and mercury) were present in the sample. Metals are problematic for thermal treatment technologies since the treatment process does not reduce metal levels and results in either pass through (volatile metals) or ash with a higher metal concentration than the original waste matrix. During incineration, the volatile metals would generate significant off-gasses, which could cause a violation of the facility's air permit. The remaining metals would not be destroyed by the treatment process and would be present in the generated ash. Thus, secondary treatment procedures would be required to address volatile metals and to dispose the ash (stabilization, solidification, etc.). SafetyKleen is not permitted to directly discharge volatile metals and does not have requisite controls available to treat such emissions.

Personnel at SafetyKleen estimated they would require approximately forty cubic yards of material for pilot testing. Personnel at SafetyKleen further stated they would be required to modify their incinerator to treat the emissions generated from the PCBs and from the volatile metals. Other concerns identified with off-Site incineration involve the heterogeneous nature of fill area waste and associated materials handling problems. Large pieces of concrete, brick, and other debris are present and would cause problems in feeding the material into the incineration unit. Thus, a pre-treatment effort would be required to segregate debris that is not suitable for incineration. Given the potential exposure problems associated with material handling and other problems stated above, it was determined by SafetyKleen and Solutia Inc. that incineration pilot testing of the fill area materials is not feasible. This information was provided to the USEPA as part of the July 2000 Area 1 monthly report. The summary memorandum previously provided to the USEPA is provided herein as Appendix A.

Leachate treatability pilot tests were conducted for Sites G and I to evaluate if pretreatment limits can be achieved prior to discharge to the American Bottoms Regional Treatment Facility. One leachate sample was collected from Site I, and one leachate sample was collected from Site G using the two-inch diameter well installed at each of these fill areas. These wells were stressed so that a representative leachate sample could be collected for subsequent testing. Pilot treatability testing was subsequently conducted by the ADVENT Group, located in Brentwood, Tennessee.

For additional information pertaining to the procedures that were followed during field work or the pilot testing program, refer to Section 3.23 (Volume 6) of the FSR.

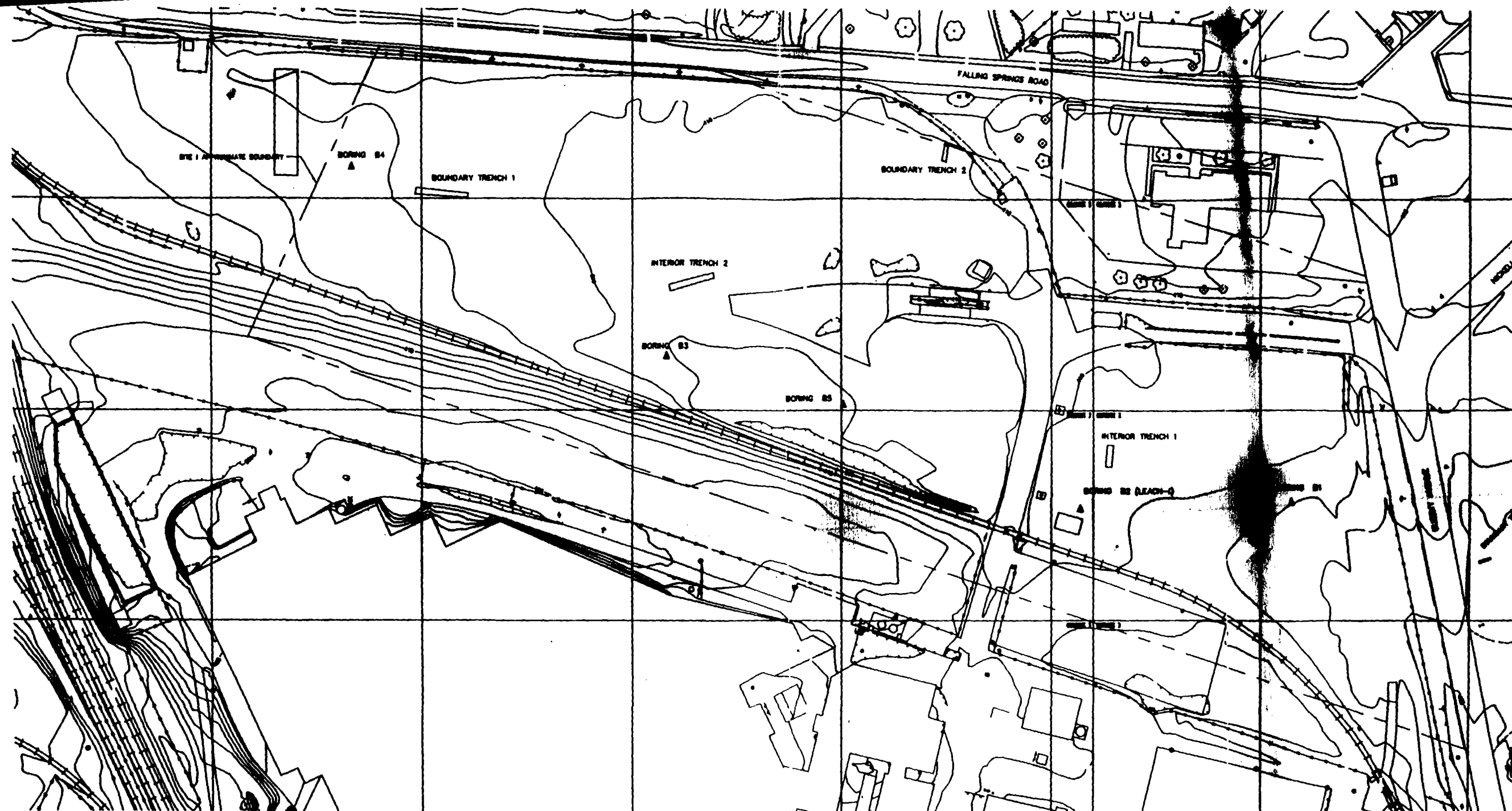
**Table 3-1**  
**Samples Collected at Saugset Area 1**

Sample	# Samples	# Analyses	QA/QC	# Analytes	Trip Blanks	# Analytes	Total
Eco Benthic Community M/C	69	1	0	0	0	1	69
Eco Plants M/C	15	7	0	0	0	1	105
Eco Macroinvertebrates M/C	10	7	0	0	0	1	70
Eco Shrimp M/C	6	7	0	0	0	1	42
Eco Forage Fish M/C	9	7	0	0	0	1	63
Eco Gamelish Fillets M/C	7	7	1	1	0	1	50
Eco Whole Gamelish M/C	7	7	1	1	0	1	50
Eco Bottom Fish M/C	7	7	0	0	0	1	49
Eco Sediment Toxicity M/C	23	1	8	1	0	1	31
Waste Surface Soil 5.3	20	9	8	9	9	1	261
Waste Surf. Soil Phys. Anal. 5.3	20	3	0	0	0	0	60
Waste Composite 5.3	25	12	15	12	13	1	493
Fill Area GW 5.7, 5.16	28	9	12	9	12	1	372
AA GW Sampling 5.8	11	9	6	9	6	1	159
Downgradient AA GW 5.9	89	8	29	8	34	1	978
Downgrad. AA GW Dioxin 5.9	27	1	14	1	0	0	41
Bedrock GW Sampling 5.10	3	9	3	9	2	1	58
Shallow Resid. GW 5.11	6	9	2	9	2	1	74
Time Series GW Sampling 5.12	6	9	2	9	3	1	75
Domestic Wells 5.13	4	9	3	9	1	1	64
Grain Size 5.15	15	1	0	0	0	1	15
Undevel. Surf. Soil 5.17	45	11	13	8	11	1	610
Undevel. Surf. Soil Dioxin 5.17	9	1	7	1	0	0	16
Undevel. Subsurf. Soil 5.17	45	8	13	8	12	1	476
Undevel. Subsurf. Soil Dioxin 5.17	9	1	7	1	0	0	16
Devel. Surf. Soil 5.18	20	9	5	9	1	1	226
Devel. Surf. Soil Dioxin 5.18	20	1	5	1	0	0	25
Devel. Subsurf. Soil 5.18	20	8	3	8	3	1	187
Devel. Subsurf. Soil Dioxin 5.18	4	1	2	1	0	0	6
Background Soil Sampling 5.19	6	9	3	9	4	1	85
Undevel./Devel. Sediment 5.20.1/2	97	7	17	7	0	0	798
Borrow Pit Sediment 5.20.3	8	7	1	7	0	0	63
Dead Creek Sediment 5.20.4	2	12	3	12	1	1	61
Eco Sediment 5.20.5	23	12	7	12	10	1	370
Surface Water 5.21	20	16	8	16	5	1	453
Air Sampling 5.22	13	5	0	0	1	1	68
<b>Total</b>	<b>748</b>	<b>247</b>	<b>198</b>	<b>187</b>	<b>130</b>	<b>28</b>	<b>6635</b>

Not included: Soil Gas Survey, Magnetometer Survey, Slug Tests, Pilot Testing





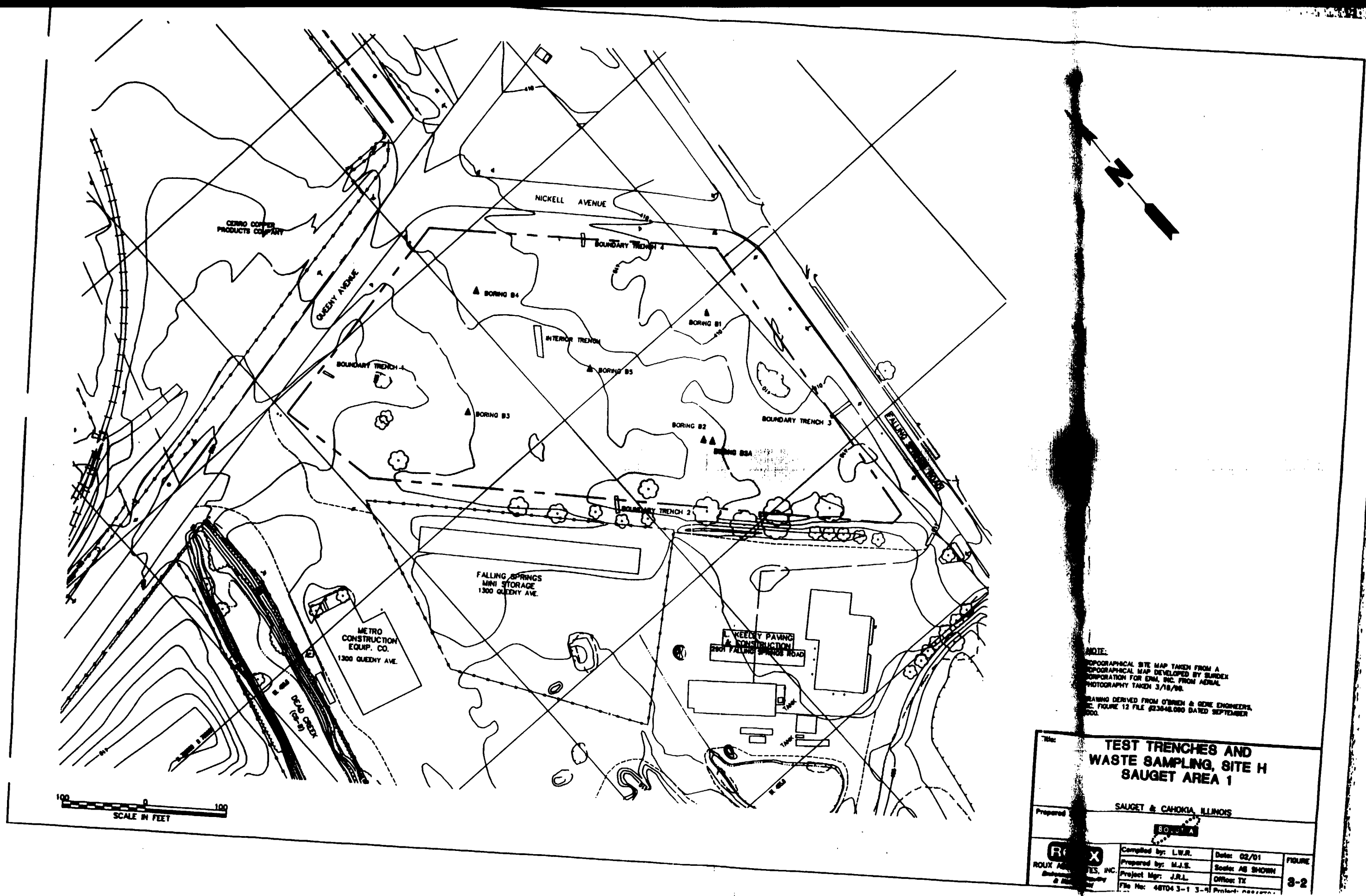


NOTE:  
 TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL  
 MAP DEVELOPED BY SLIDEX CORPORATION FOR EPA, INC.  
 FROM AERIAL PHOTOGRAPHY TAKEN 3/18/88.  
 DRAWING DERIVED FROM O'BRIEN & GENE ENGINEERS, INC.  
 FIGURE 13 FILE #23848.080 DATED SEPTEMBER 2000.

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 SCALE IN FEET

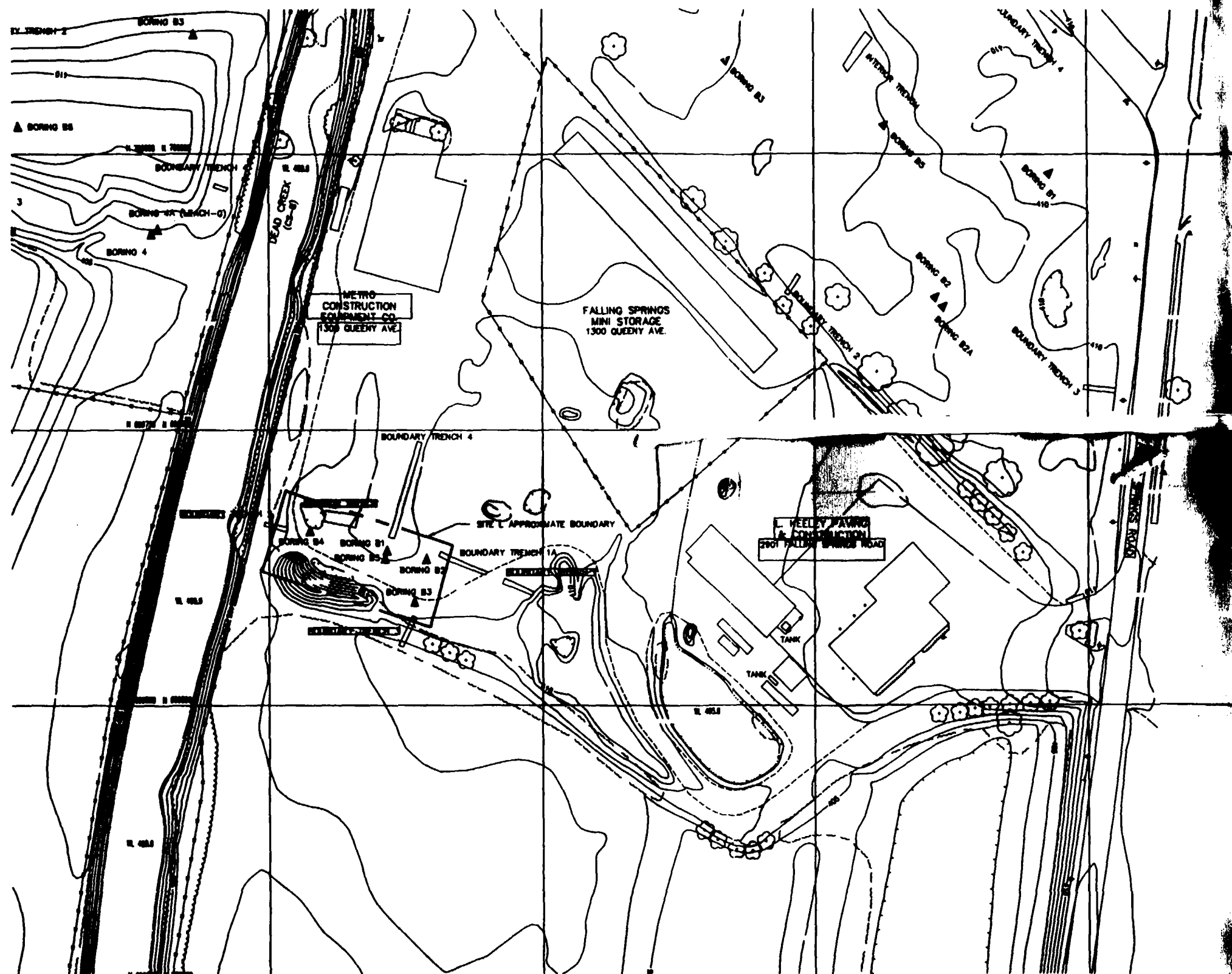


Title: TEST TRENCHES AND WASTE SAMPLING, SITE 1 SAUGET AREA 1			
Location: SAUGET & CAHOKIA, ILLINOIS			
Prepared by: [Signature]			
 ROUX ASSOCIATES, INC. Environmental Engineering & Management	Compiled by: L.W.R.	Date: 02/01	FIGURE  3-8
	Prepared by: M.J.B.	Scale: AS SHOWN	
	Project Mgr: J.R.L.	Office: TX	
	File No: 48704.3-1 3-8	Project: 00848704	



NOTE:  
 TOPOGRAPHICAL SITE MAP TAKEN FROM A  
 TOPOGRAPHICAL MAP DEVELOPED BY SURDEX  
 CORPORATION FOR ENR, INC. FROM AERIAL  
 PHOTOGRAPHY TAKEN 3/18/98.  
 DRAWING DERIVED FROM O'BRIEN & GENE ENGINEERS,  
 INC. FIGURE 12 FILE #23048.000 DATED SEPTEMBER  
 2000.

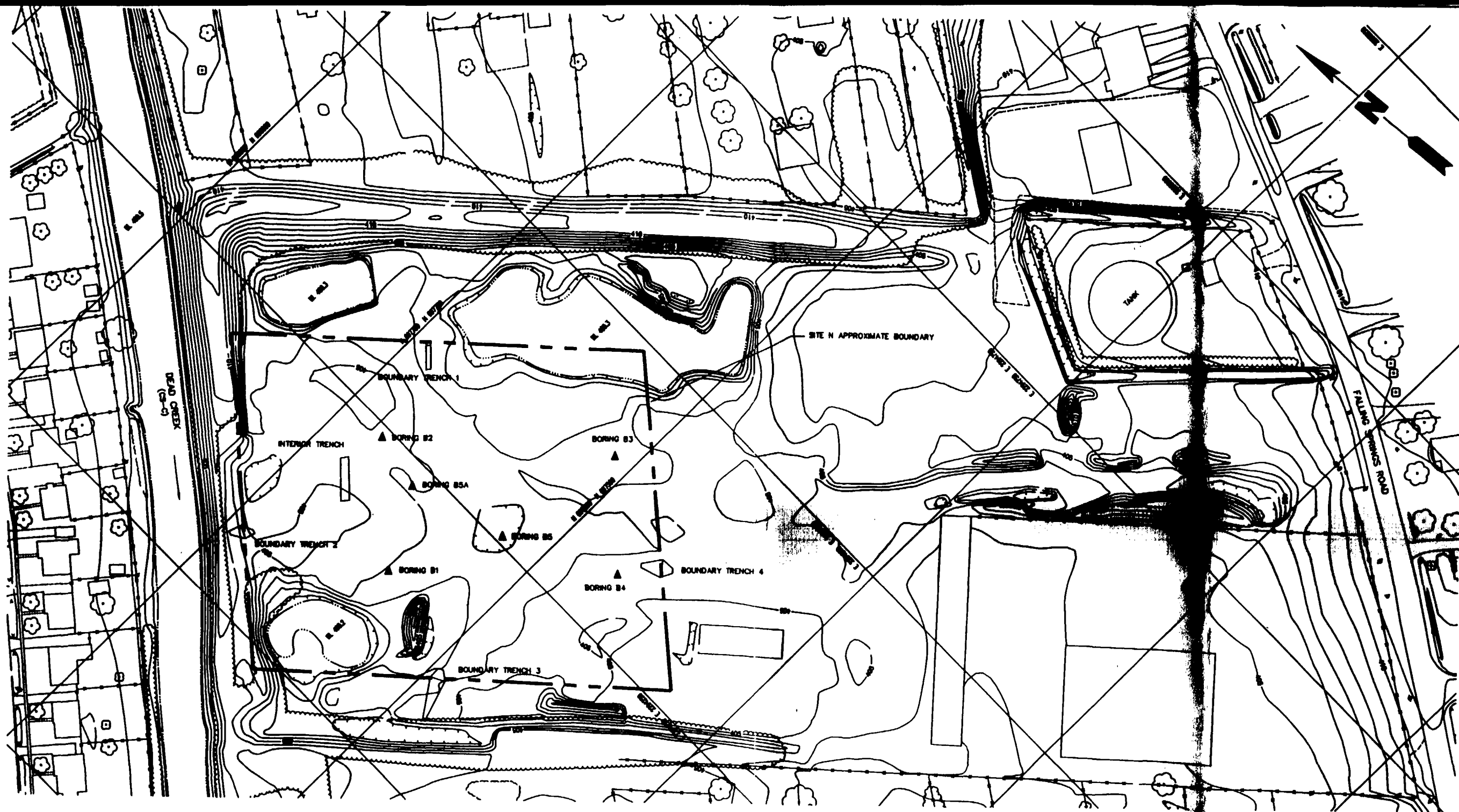
<b>TEST TRENCHES AND          WASTE SAMPLING, SITE H          SAUGET AREA 1</b>			
Prepared: SAUGET & CAHOKIA, ILLINOIS			
80-000000			
<b>ROUX</b> ROUX ASSOCIATES, INC. Environmental & Engineering	Compiled by: L.W.R.	Date: 02/01	FIGURE <b>3-2</b>
	Prepared by: M.J.S.	Scale: AS SHOWN	
	Project Mgr: J.R.L.	Office: TX	
	File No: 48T04 3-1 3-9 Printed: 000000		



100 0 100  
SCALE IN FEET

NOTE:  
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MAP DEVELOPED BY SUNDEX CORPORATION FOR ERM, INC.  
FROM AERIAL PHOTOGRAPHY TAKEN 3/18/86.  
DRAWING DERIVED FROM O'BRIEN & GENE ENGINEERS, INC.  
FIGURE 14 FILE #23548.080 DATED SEPTEMBER 2000.

Title: <b>TEST TRENCHES AND WASTE SAMPLING, SITE L SAUGET AREA 1</b>			
Prepared For: <b>SAUGET &amp; CAHOKIA, ILLINOIS</b>			
<b>SAUGET</b>			
<b>ROUX</b> ROUX ASSOCIATES, INC. <i>Environmental Consulting</i>	Compiled by: L.W.R. Prepared by: M.J.S. Project Mgr: J.R.L.	Date: 02/01 Scale: AS SHOWN Office: TX	FIGURE <b>3-4</b>



NOTE:  
 TOPOGRAPHICAL SITE MAP TAKEN FROM A  
 TOPOGRAPHICAL MAP DEVELOPED BY SURDEX  
 CORPORATION FOR ERM, INC. FROM AERIAL PHOTOGRAPHY  
 TAKEN 3/18/98.  
 DRAWING DERIVED FROM O'BRIEN & GENE ENGINEERS, INC.  
 FIGURE 15 FILE #23648.080 DATED SEPTEMBER 2000.

100 0 100  
 SCALE IN FEET

# TEST TRENCHES AND WASTE SAMPLING, SITE N SAUGET AREA 1

SAUGET & CAHOKIA, ILLINOIS

Prepared For:

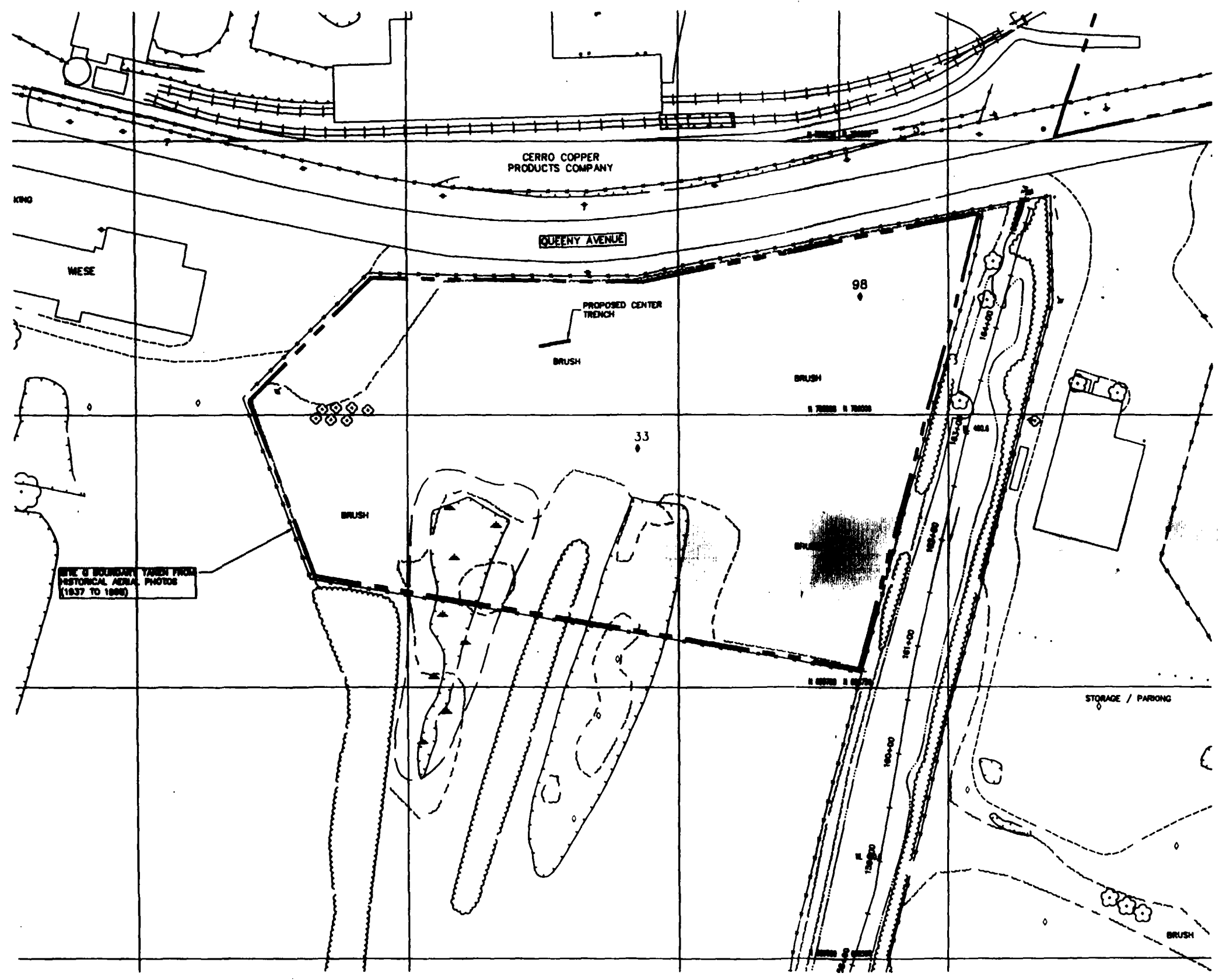
BOULDERIA

**ROUX**  
 ASSOCIATES, INC.  
 Environmental Consulting  
 & Management

Compiled by: L.W.R.  
 Prepared by: M.A.S.  
 Project Mgr: J.R.L.  
 File No: 48TD4.3-1 3-8

Date: 02/01  
 Scale: AS SHOWN  
 Office: TX  
 Project: 08846T04

FIGURE  
 3-5



- LEGEND**
- 33 3'-8" SOIL GAS DETECTS
  - 0 3'-8" SOIL GAS NON-DETECTS
  - PROPOSED CENTER TRENCH

**NOTE:**

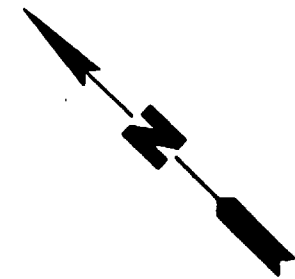
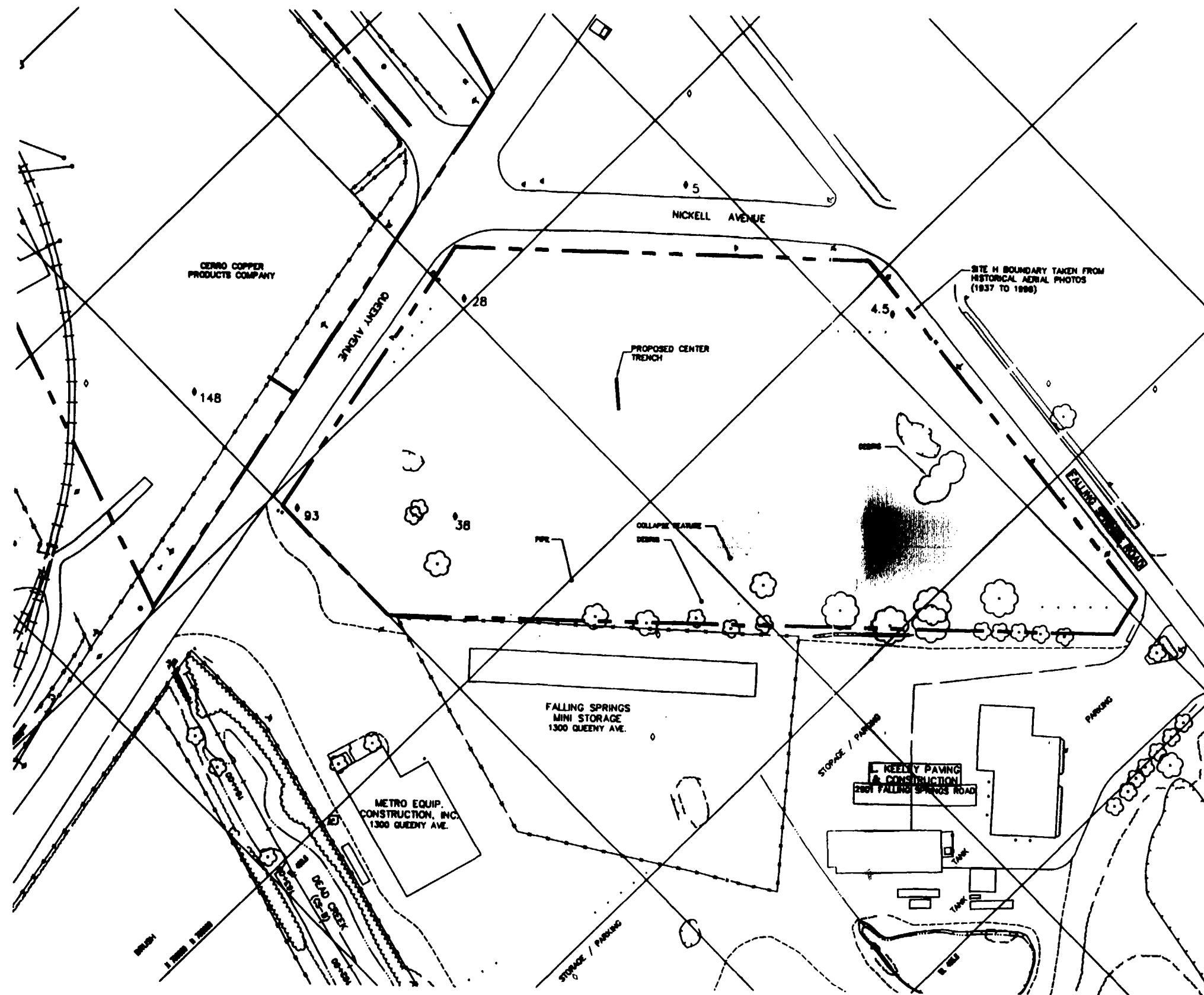
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DRAWING DERIVED FROM O'BRIEN & GORE ENGINEERS INC. FIGURE 8 FILE #23848.002.04 DATED SEPTEMBER 2000.

NUMBERS SHOWN INDICATE RELATIVE VOC CONCENTRATIONS (UNTILS) MEASURED BY PID.



<b>SOIL GAS SURVEY SITE G SAUGET AREA 1</b>			
SAUGET & CAHOKIA, ILLINOIS			
Prepared For: <b>SOUGET</b>			
<b>NOU</b> ASSOCIATES, INC. Environmental Consulting Management	Compiled by: L.W.R.	Date: 02/01	<b>FIGURE 3-6</b>
	Prepared by: M.J.S.	Scale: AS SHOWN	
	Project Mgr: J.R.L.	Office: TX	
	File No: 48704.3-6 3-10 Project: 08848704		

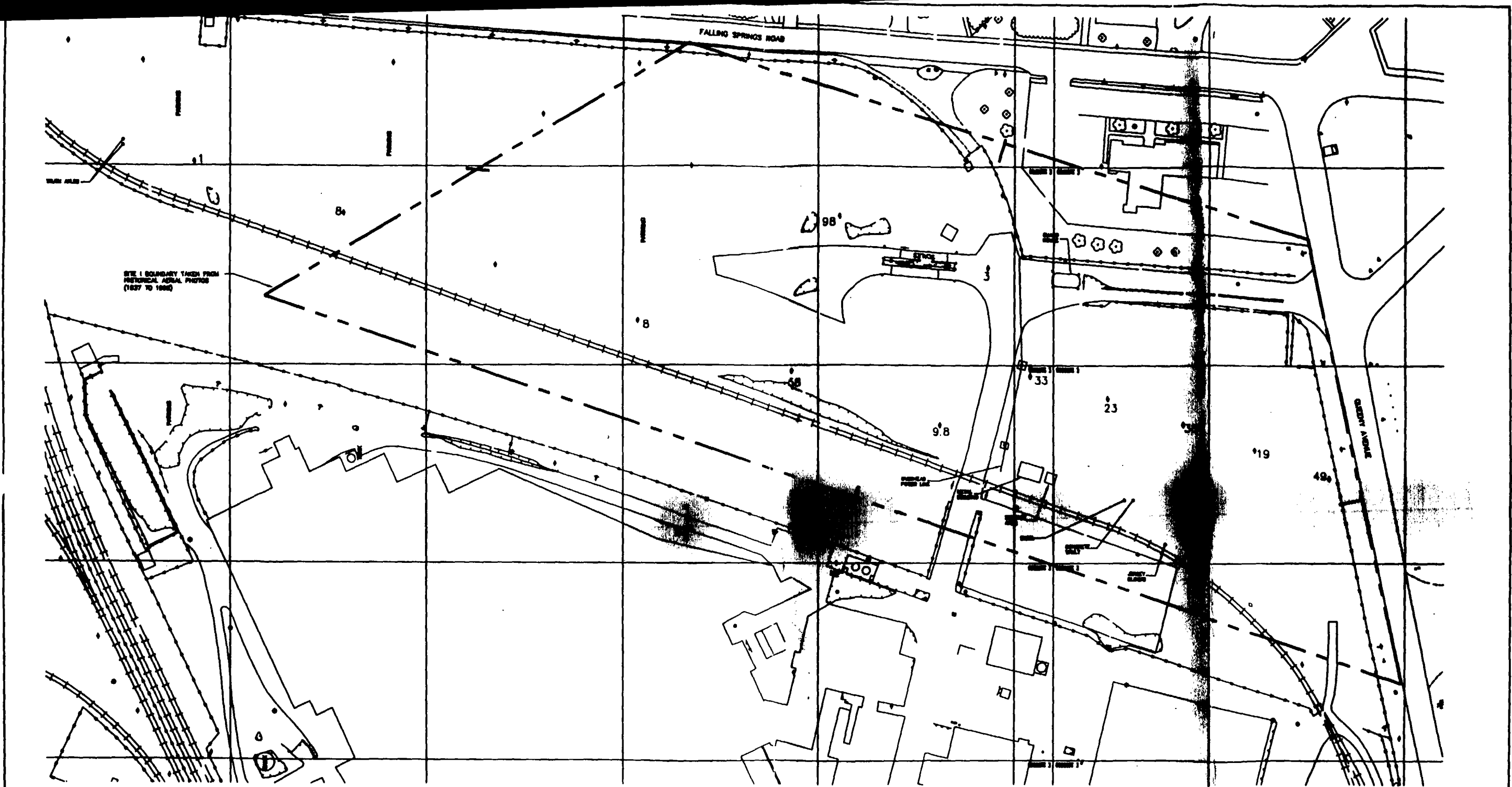


- LEGEND**
- 3'-5' SOIL GAS DETECTS
  - 3'-5' SOIL GAS NON-DETECTS
  - PROPOSED CENTER TRENCH

**NOTE:**  
 TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL MAP DEVELOPED BY SURDEX CORPORATION FOR ERM, INC. FROM AERIAL PHOTOGRAPHY TAKEN 3/18/98.  
 DRAWING DERIVED FROM O'BRIEN & GORE ENGINEERS, INC. FIGURE 7 FILE #23648.002.02 DATED SEPTEMBER 2000.  
 NUMBERS SHOWN INDICATE RELATIVE VOC CONCENTRATIONS (UNTILLES) MEASURED BY FD.



<b>SOIL GAS SURVEY</b> <b>SITE H</b> <b>SAUGET AREA 1</b>			
SAUGET & CAHOKIA, ILLINOIS			
Prepared For: <b>SOUGET</b>			
<b>SOUG</b> SOUGER ASSOCIATES, INC. Environmental Consulting & Engineering	Compiled by: L.W.R.	Date: 02/01	<b>FIGURE</b>  <b>3-7</b>
	Prepared by: M.J.S.	Scale: AS SHOWN	
	Project Mgr: J.R.L.	Office: TX	
	File No: 46TD4.3-8 3-10 Project: 00046TD4		



LEGEND  
 33' PROPOSED BOUNDARY TRENCH  
 0 3'-5' SOIL GAS NON-DETECTS

#### NOTE:

TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL MAP DEVELOPED BY SURDEX CORPORATION FOR ERM, INC. FROM AERIAL PHOTOGRAPHY TAKEN 3/18/79.

DRAWING DERIVED FROM O'BRIEN & SENE ENGINEERS, INC. FIGURE 6 FILE #23648.002.08 DATED SEPTEMBER 2000.

NUMBERS SHOWN INDICATE RELATIVE VOC CONCENTRATIONS (UNTILLES) MEASURED BY FID.

120 0 120  
 SCALE IN FEET

#### SOIL GAS SURVEY SITE 1 SAUGAT AREA 1

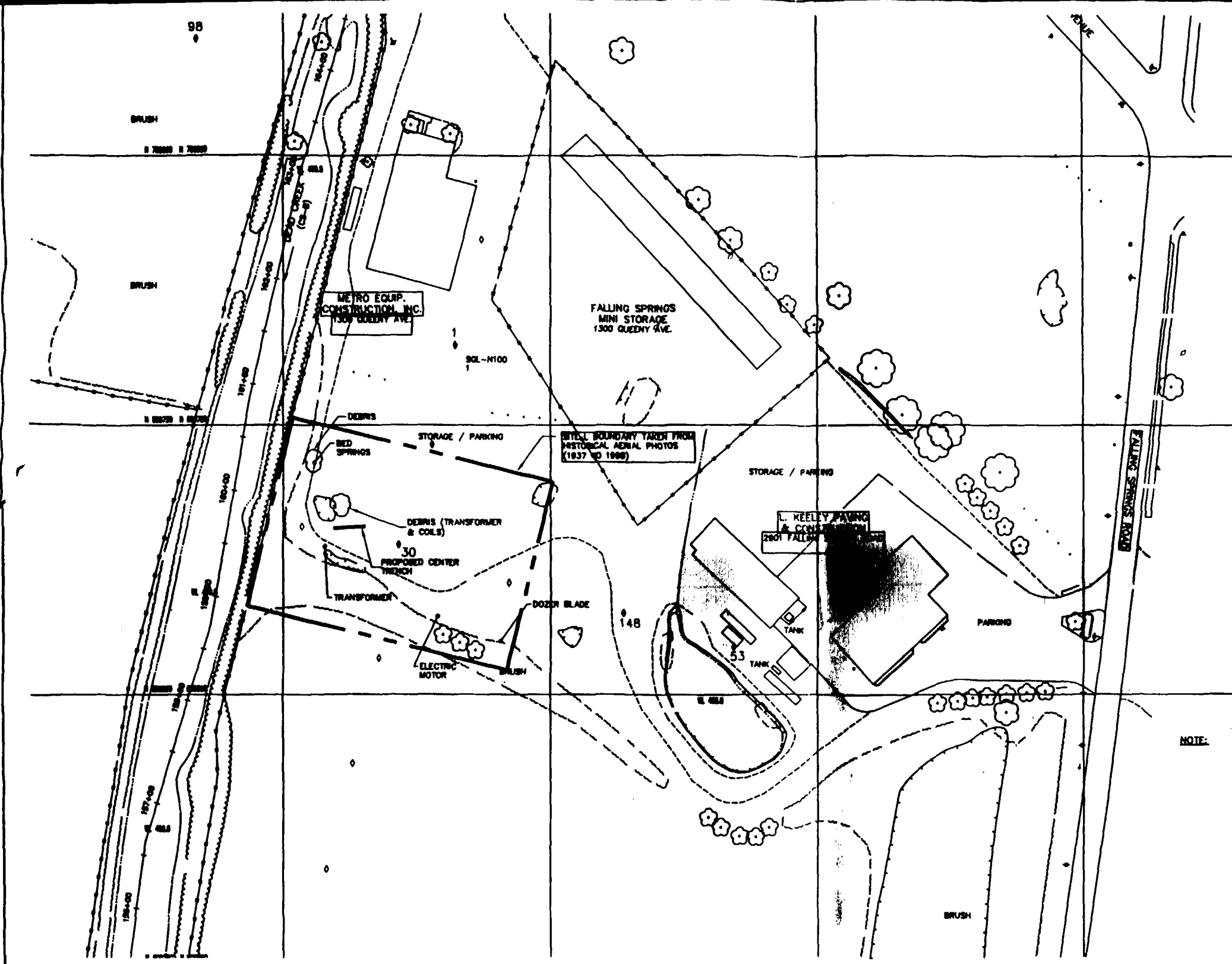
SAUGAT & CAHOKIA, ILLINOIS

Prepared For: **SOUGAT**

**OUX**  
 RSC ASSOCIATES, INC.  
 Environmental Consulting  
 & Management

Compiled by: L.W.R.	Date: 02/01	FIGURE <b>3-8</b>
Prepared by: M.J.S.	Scale: AS SHOWN	
Project Mgr: J.R.L.	Office: TX	
File No: 48704.3-8 3-10	Project: 00848704	





33  
 3'-5' SOIL GAS DETECTS  
 0 3'-5' SOIL GAS NON-DETECTS  
 — PROPOSED CENTER TRENCH

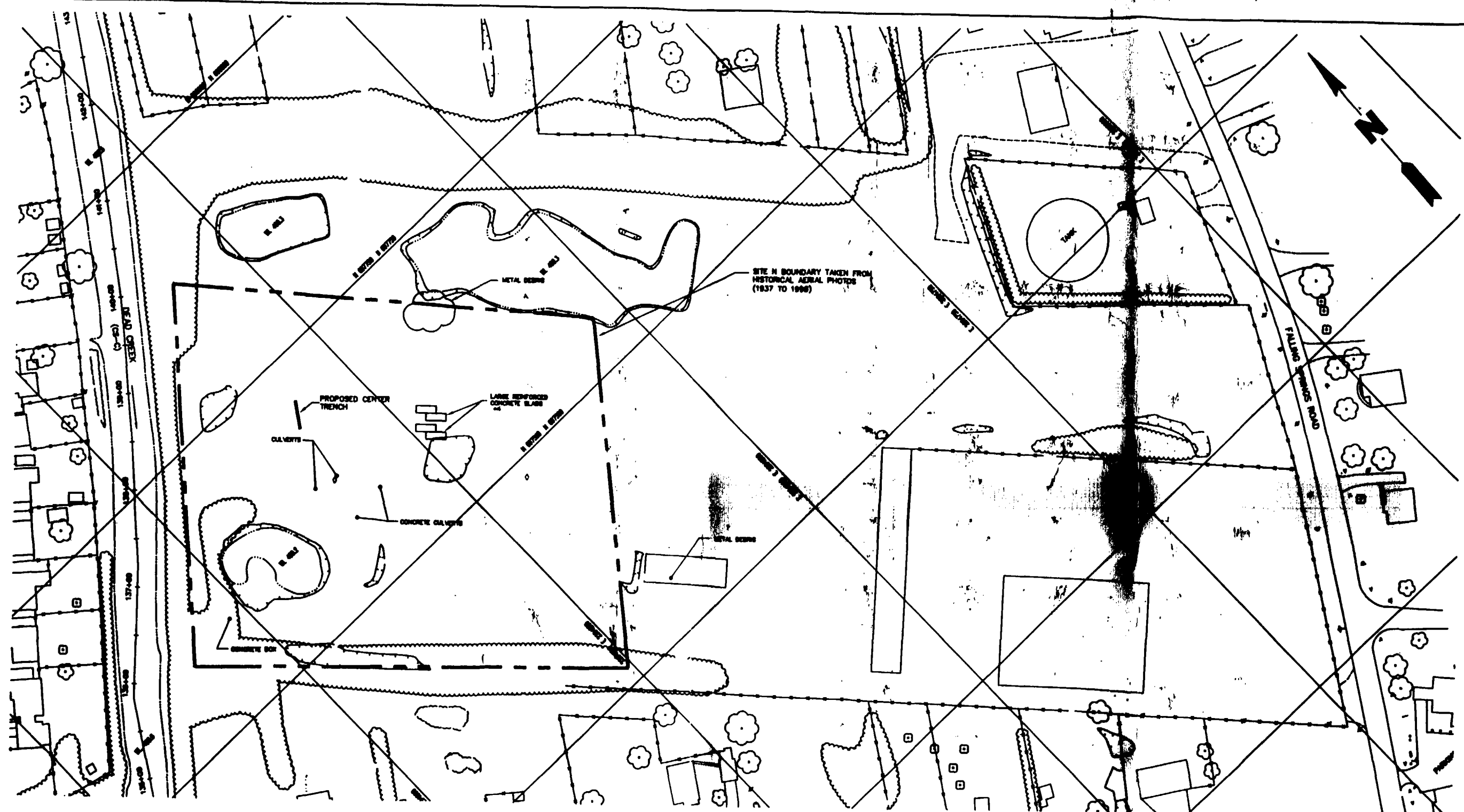
100 0  
 SCALE IN FEET

NOTE:

NOTE:  
 TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL  
 MAP DEVELOPED BY BURCH CORPORATION FOR EDM, INC.  
 FROM AERIAL PHOTOGRAPHY TAKEN 3/18/88.  
 DRAWING DERIVED FROM O'BRIEN & GENE ENGINEERS, INC.  
 FIGURE 9 FILE #23648.002.00 DATED SEPTEMBER 2000.  
 NUMBERS SHOWN INDICATE RELATIVE VOC CONCENTRATIONS  
 (UNITLESS) MEASURED BY FID.

Title: <b>SOIL GAS SURVEY SITE L SAUGET AREA 1</b>			
Prepared For: <b>SAUGET &amp; CAHOKIA, ILLINOIS</b>			
<b>ROUX</b> ROUX ASSOCIATES, INC. <i>Environmental Consulting &amp; Management</i>		Compiled by: L.W.R. Prepared by: M.J.S. Project Mgr: J.R.L. File No: 48704.3-6 3-10	Date: 02/01 Scale: AS SHOWN Office: TX Project: 08648704
			FIGURE <b>3-9</b>





- 33
- LEGEND**
- 3'-8" SOIL GAS DETECTS
  - 3'-8" SOIL GAS NON-DETECTS
  - PROPOSED CENTER TRENCH

**NOTE:**

TOPOGRAPHICAL SITE MAP TAKEN FROM A TOPOGRAPHICAL MAP DEVELOPED BY SURDEX CORPORATION FOR ILL. INC. FROM AERIAL PHOTOGRAPHY TAKEN 3/18/96.

DRAWING DERIVED FROM G'WREN & SONS ENGINEERING, INC. FIGURE 10 FILE #83048.002L01 DATED SEPTEMBER 1996.

NUMBERS SHOWN INDICATE RELATIVE VOC CONCENTRATIONS (UNTILERS) MEASURED BY FID.



<b>TRUE:</b>			
<b>SOIL GAS SURVEY SITE N SAUGET AREA 1</b>			
<b>SAUGET &amp; CAHOKIA, ILLINOIS</b>			
<b>Prepared For:</b>			
<b>ROUX</b>			
Completed by: L.W.R. Prepared by: M.J.S. Project Mgr: J.R.L. File No: 46704.3-8	Date: 02/01 Status: AS SHOWN Office: TX Project: 08846704	<b>FIGURE 3-10</b>	

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#### **4.0 SUPPORT SAMPLING PLAN SITE INVESTIGATION RESULTS**

As outlined in Section 3.0 of this document, investigations have been conducted at five previously defined fill areas adjacent to Dead Creek and five Creek Segments of Dead Creek. Additionally, ground-water, surface-water, soil, air, treatability study and ecological investigations have been conducted in Area 1. Section 3.0 provides a summary of the work that was accomplished during each of these investigations, and the FSR provides more in-depth descriptions of the field procedures and all field documentation and logs.

After the data from this investigation were collected and validated, the data were combined into separate groups and color dot maps were prepared to illustrate the spatial distribution of constituent concentrations throughout Area 1. These data groups varied depending upon the media that were sampled; however, the groups generally consisted of total VOCs, SVOCs, herbicides, pesticides, dioxins, PCBs, and selected inorganics (metals). One color dot map is provided for each of these constituent groups per area. The various colors and sizes of these dots represent different ranges of constituent concentrations, as explained on the legends of each drawing. These dot maps and tabulated data used to construct the maps were submitted to the USEPA as an *EE/CA and RI/FS Support Sampling Plan Data Report (DR)* in January 2001.

As part of the SSP data evaluation process, analytical data were grouped by media, and tables were constructed tabulating the minimum, mean, maximum and 95 percent upper confidence limit concentrations for each data group. Duplicate sample values were averaged prior to calculating the statistics, and one-half the sample quantitation limit (SQL) was used as a proxy value for non-detected data when constituents were found in some samples and not in others. However, if one-half the SQL was greater than the maximum detected concentration, that sample was not included in the summary statistics. Constituents not found in any of the samples for a particular medium are not reported on the tables. In calculating the 95 percent upper confidence limit values, the data sets were initially evaluated using the Shapiro-Wilk Test for normality. The upper confidence limit based on the t-statistic was selected for a

normal distribution, and the upper confidence limit based on the H-statistic was chosen for lognormal distributions. These tables and the previously constructed color dot maps are used in this section to present and interpret the results of the SSP investigation program. The following subsections describe the nomenclature used in the sample numbering and refer to the appropriate figures and tables. All of the data generated during this investigation and presented in this section are available in the DR. An analysis of the source, nature and extent of contamination is presented in Section 5.0.

#### **4.1 Fill Area Investigation Results**

The fill area investigation initially involved efforts to accurately define the fill area boundaries at the Site. Once the fill areas and other points of interest were located, boundary confirmation trenches and waste characterization borings were located in the field using GPS technology. The excavation of the boundary trenches was discussed in Section 3.1 of the FSR, and the results are discussed in the following subsection (Section 4.1.1). Other work completed in the fill area investigation included a soil gas survey, waste sampling, magnetometer survey, and buried drum and tank identification. The results of these investigations are presented in Section 4.1.2 through 4.1.4.

##### **4.1.1 Fill Area Boundary Survey (Boundary Confirmation Trenches)**

Boundary confirmation trenches (test trenches) were used to confirm the boundaries of the fill areas identified through aerial photograph analysis. The original plan was to excavate a trench on each side of each fill area (four trenches per site). However, due to access limitations, the number of trenches varied per site. Additionally, test borings were substituted for test trenches on the west border of Site G where access was an issue. Twenty-two trenches were excavated, and eight test borings were advanced as shown on Figures 3-1 through 3-5.

All four boundaries of Sites G, H, L, and N were identified during the trenching and boring study. Only two sides of Site I required identification (north and east) due to general knowledge of the fill extent to the south and west.

#### **4.1.2 Soil Gas Survey**

As described in Section 3.2.1 of this report, Sites G, H, I, L, and N were divided into grids and investigated with a soil gas probe. Twenty-nine soil gas samples were collected from pre-determined grid locations. When detectable VOCs were measured during this investigation, additional samples were collected along four transects perpendicular to the respective grid (one transect per each side of the square grid). Thirty-six additional samples were collected along these transects (four transects per grid were not possible in some cases due to access limitations). The sample locations are shown on Figures 3-6 through 3-10.

#### **4.1.3 Waste Sampling**

As described in Section 3.2.2, four sample borings and one screen boring were advanced at Sites G, H, I, L, and N. The borings were advanced through the fill area and into native soil. The one boring designated as the screen boring was advanced to a depth of approximately 15 feet below the fill material. One waste composite sample and one discrete surface soil sample were collected from each boring and submitted for analysis. In addition, PID analyses were performed on native soils below the waste in the screen borings.

The following subsections (Sections 4.1.3.1 and 4.1.3.2) describe the nomenclature and results from the surface and subsurface fill area sampling. The results are presented by reference to the corresponding color dot figures and data summary tables. Note that the data in the data tables have been consolidated to present the statistical values of constituents per fill area. For example, the data from the surficial soil samples from all four sampling locations at Site G were combined in tabular format to illustrate the statistical concentrations (i.e., minimum, mean, maximum) of each constituent at that particular site.

##### **4.1.3.1 Discrete Surface Sampling Analyses**

The nomenclature used for these analyses was as follows: WASTE-G-B1-0-0.5FT. The "WASTE" nomenclature identifies the sample as a fill area sample; "G" identifies the fill area that the sample was collected from; "B1" identifies the boring number (four sample borings

per fill area); and "0-0.5 FT" identifies the sample interval (0-0.5 feet for all discrete surface samples).

Tables 4-1 through 4-5 present the summary statistical data for the discrete surface sampling analyses from the fill area surface samples. Color dot maps displaying the discrete surface sample data from each fill area are provided as Figures 4-1 through 4-10.

#### **4.1.3.2 Waste Subsurface Composite Sample Analyses**

The nomenclature used for the waste composite samples was as follows: WASTE-G-B1-COMP. This nomenclature is the same as for the discrete surface samples except the letters "COMP" are inserted instead of a sampling depth. The label "COMP" identifies that the sample was composited over the boring profile. Samples to be analyzed for VOCs were not composited due the potential loss of volatile organics. In these cases, the sample interval replaced COMP on the sample number. For the samples that were not composited, the sample interval that had the highest PID reading was submitted for analysis.

Tables 4-6 through 4-10 present the summary statistic data for the waste composite sample analysis from the fill areas. Color dot maps displaying the waste composite data from each fill area are provided on Figures 4-11 through 4-17. Constituent concentrations detected in the waste composite samples were determined in a laboratory using the TCLP method with the exception of sulfide, pH, cyanide and PCB analyses.

#### **4.1.4 Buried Drum and Tank Identification Results**

In addition to surface and waste material sampling, test trenches were excavated at each of the source areas (except Site M) to confirm the presence or absence of buried metallic containers (tanks or drums). One test confirmation trench was excavated at Sites G, H, L, and N. Two confirmation test trenches were excavated at Site I.

Most of the waste encountered during the test confirmation trenching was glass containers, wood and metal debris, paper documentation (bill of lading, invoices, brochures, etc.) and miscellaneous trash. Although the investigation targeted potential hot spots, no buried tanks or drum caches were located. The number of drums that were located as a result of the test confirmation trenching is as follows:

Site G	11
Site H	Unknown, found several drum fragments and drum lids
Site I	Approximately 12
Site L	18
Site N	8 plus additional drum fragments

None of the drums that were located during the drum and tank identification study were intact [except for one intact drum that was located during a fill area boundary confirmation trench (see FSR for details)]. Most were either crushed or rusted and were not capable of holding liquid contents. Solid contents were noted in some of the buried drums. Each of the source areas was restored to its original condition at the conclusion of trenching operations.

#### **4.2 Ground-Water Investigation Results**

As described in Section 3.3 of this document, ground-water samples were collected to further delineate ground-water conditions in Area 1. For purposes of this discussion, the shallow hydrogeologic unit (SHU) in the unconsolidated alluvial aquifer includes the interval from the ground surface to a depth of 30 feet. The middle hydrogeologic unit (MHU) ground-water zone includes the depth interval of 30 to 70 feet. The deep hydrogeologic unit (DHU) includes the interval from a depth of 70 feet to bedrock. Existing and new locations were sampled to obtain representative ground-water samples for the following general conditions:

- Fill Area Ground-Water Sampling - sampling of the shallow ground-water zone within or adjacent to Sites G, H, I and L
- Alluvial Aquifer Sampling - sampling beneath Sites H and I in the MHU and DHU



- Downgradient Alluvial Aquifer Sampling - sampling downgradient and cross-gradient from Sites G, H, I and L within the SHU, MHU, and DHU
- Alluvial Aquifer/Bedrock Interface Sampling - sampling of ground water within the alluvial aquifer/bedrock interface beneath Sites G, H and I
- Shallow Residential Area Ground-Water Sampling - sampling of the SHU and MHU within residential areas
- Time-Series Sampling - sampling at specific time intervals after sustained pumping of the SHU and MHU in residential areas
- Domestic Well Sampling - sampling from existing domestic wells
- Upgradient Ground-Water Sampling - sampling of the SHU, MHU, and DHU upgradient of Sites G, H, I and L

Sections 4.2.1 through 4.2.6 describe the nomenclature and results from the ground-water sampling program. The results are presented by reference to the corresponding color dot figures and data summary tables. The ground-water data for all of the areas are presented in a consolidated set of figures (Figures 4-18 through 4-27) by constituent category. The data in the data summary tables have been consolidated to present the statistical values of constituent concentrations in selected areas. For example, the data from the ground-water sampling near (fill area sampling), downgradient, and southwest of Site I (Table 4-11) and Sites G, H, and L (Table 4-12) have been consolidated. Thus, summary statistics from these tables represent data points from several areas that are inclusive in one or more of the following subsections. Furthermore, ground-water data from all residential areas (including the domestic wells) are combined in Table 4-13. Ground-water data from the upgradient locations were not included in the data summary tables.

#### **4.2.1 Fill Area Ground-Water Sampling**

Fill area ground-water sampling consisted of collecting ground-water samples from within or adjacent to Sites G, H, I and L. The following wells were included in the fill area ground-water sampling (wells which were inaccessible for sampling were sampled by installing an adjacent probe point location and are designated by the suffix GP):

SITE G	SITE H	SITE I	SITE L
EE-05	EE-01	EE-12-GP	EEG-103
EEG-101	EE-02	EE-13-GP	EEG-105
EEG-102	EE-03	EE-14-GP	EEG-109
EEG-104	EEG-110	EE-15-GP	
EEG-106			
EEG-107			
EEG-111			
EEG-112			

Thus, the nomenclature for the fill area ground-water sampling results was either the corresponding well number where the sample was collected, or the well number followed by the symbol GP. EEG-111 was described in the Support Sampling Plan as "South of Site G," so it was grouped with the Site G data.

Generally, samples were obtained from wells with screen intervals above 30 feet below grade. One location, EE-14 was screened to a depth of 38 feet; however, this is still believed to be within the depth of Fill Area I. Tables 4-11 and 4-12 present the summary statistic data for the ground-water samples collected adjacent to and downgradient of Sites I, and Sites G, H, and L, respectively. Color dot maps displaying the fill area ground-water sampling results are provided as Figures 4-18 through 4-27.

#### **4.2.2 Alluvial Aquifer Sampling**

Alluvial aquifer sampling consisted of collecting ground-water samples from the MHU and DHU beneath Sites H and I. The nomenclature used for this sampling was as follows: AA-H-S1. The label "AA" identifies that the sample is a ground-water sample collected from the

alluvial aquifer. The label "H" identifies that the sample was collected from beneath Site H, and the label "S1" identifies the sample number.

Sampling stations AA-H-S1 and AA-I-S4 were installed to sample at discrete depth intervals beneath Sites H and I, respectively. Samples were collected between depths of 44 feet and 105 feet below ground surface. Tables 4-11 and 4-12 present the summary statistic data for the ground-water samples collected adjacent to and downgradient of Sites I, and Sites G, H, and L, respectively. Color dot maps displaying the constituent concentrations from the sampling efforts are provided on Figures 4-18 through 4-27.

#### **4.2.3 Downgradient Alluvial Aquifer Sampling**

Downgradient alluvial aquifer sampling including sampling of three-well transects downgradient of Site I, downgradient of the combined Sites G, H and L, and southwest of Sites G, H, I and L, respectively. The three-well transects comprised the following sampling stations:

Downgradient of Site I	Downgradient of Sites G, H and L	Southwest of Sites G, H, I and L
AA-I-S1	AA-GHL-S1	AA-SW-S1
AA-I-S2	AA-GHL-S2	AA-SW-S2
AA-I-S3	AA-GHL-S3	AA-SW-S3

In all cases, stations with the *S1* suffix are closest to the fill areas, and stations with the *S3* suffix are farthest from the fill areas. Ground-water samples were collected from the SHU, MHU, and the DHU. Sample collection began at the static water table and continued every ten feet until bedrock was encountered.

Twenty-eight discrete zone ground-water samples were collected from the three-well transect downgradient of Site I. Thirty-one discrete zone ground-water samples were collected from the three-well transect downgradient of Sites G, H, and L. Thirty discrete zone ground-water samples were collected from the three-well transect southwest of Sites G, H, I, and L. Tables

4-11 and 4-12 present the summary statistic data for the ground-water samples collected adjacent to and downgradient of Sites I, and Sites G, H, and L, respectively. Color dot maps displaying the constituent concentrations are provided as Figures 4-18 through 4-27.

#### **4.2.4 Upgradient Sampling**

Upgradient ground-water sampling consisted of obtaining samples from the shallow, middle and deep hydrogeologic units from each of three sampling locations. UGGW-EE-20 was located upgradient of Site I. UGGW-EE-04 was located upgradient of Site H. UGGW-EE-108 was located upgradient of Site L. A total of nine ground-water samples was collected. Color dot maps displaying the constituent concentrations are provided as Figures 4-18 through 4-27.

#### **4.2.5 Shallow Residential Area, Time-Series and Domestic Ground-Water Sampling**

Ground-water samples were collected from two locations representative of residential areas. Both locations were located in the central portion of Area 1. Three samples were collected from each well at approximate depths of 15 feet, 20 feet and 40 feet, for a total of six samples. Following the initial sampling, the locations were pumped over a period of 24 hours and samples were collected at the start of pumping, after 12 hours of pumping, and after 24 hours of pumping. The data from the shallow residential area sampling are summarized in Table 4-13. Color dot maps displaying the constituent concentrations are provided as Figures 4-18 through 4-27.

Four domestic wells were sampled. These wells are located in the central portion of Sauget Area 1, and are less than 500 feet from one another. The data for this sampling event are summarized in Table 4-13 (the data from the domestic well ground-water sampling events were combined with the shallow residential ground-water samples). Color dot maps displaying the constituent concentrations are provided as Figures 4-18 through 4-27.

#### **4.2.6 Ground-Water Flow Direction and Slug Tests**

To determine the ground-water flow direction at Area 1, the potentiometric surface was measured in nine sets of wells as described in Section 3.3.2. These wells were screened in the SHU, MHU and the DHU. These data were plotted on a drawing and contoured to determine the ground-water flow direction for all three hydrogeologic units. Figures 4-28 through 4-33 show these potentiometric surface contours for the ground-water data collected during the first and second quarters of 2000. The ground-water flow direction is to the west at an approximate gradient of one foot vertical to 1,000 feet horizontal. The ground-water flow direction in the wells screened in the alluvial aquifer/bedrock interface is also to the west.

Fifteen slug tests were conducted to determine the hydraulic parameters of the SHU, MHU, and DHU, as described in Section 3.3.3. Slug test locations are shown on Figure 4-34, with the prefix "ST". Table 4-14 summarizes the results from these tests. Supporting documentation, such as selected raw data and the data type curves, are provided in Appendix B. Hydraulic conductivity for the SHU ranged from  $2.44 \times 10^{-3}$  to  $2.71 \times 10^{-2}$  centimeters per second (cm/s),  $2.14 \times 10^{-2}$  to  $5.07 \times 10^{-2}$  cm/s for the MHU, and  $1.37 \times 10^{-2}$  to  $1.27 \times 10^{-1}$  cm/s for the DHU.

#### **4.3 Soil Investigation Results**

As presented in Section 3.4.1 of this document, soil samples were collected along seven transects in Area 1 to evaluate the extent of migration due to overbank flooding and wind-blown dust deposition. The seven transects are located in undeveloped areas in Area 1. These transects extended perpendicularly from Dead Creek, and the sampling stations were located on 200-foot intervals along each transect. In addition, three more sampling stations were placed in developed areas adjacent to transects 1 through 6, and two developed area sampling stations were placed adjacent to transect 7.

The following subsections (Sections 4.3.1 through 4.3.3) describe the nomenclature and results from the surface and subsurface soil sampling. The results are presented by reference to the corresponding color dot figures and data summary tables. Note that the data summary tables have consolidated data from all transects in the undeveloped and developed areas. Thus, the data from the surficial soil samples from all undeveloped and developed transects were combined in tabular format to illustrate the statistical concentrations of each constituent throughout Area 1. This table (Table 4-15) is titled Floodplain Soils – Surface Sample Summary. Likewise, all subsurface soils in each transect were combined and are presented in a single table (Table 4-16) titled Floodplain Soils – Subsurface Sample Summary. Data from the background soil samples were not included in the data summary tables.

#### **4.3.1 Undeveloped Area Soil Sampling**

Forty-five sampling stations were placed along seven transects in undeveloped areas in Area 1. At each of these sampling stations, one surface sample and one subsurface soil were collected and analyzed for cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs. The surface sample was collected at the ground surface down to a depth of 0.5 feet, and the subsurface soil sample was collected at an interval from three to six feet. Each sampling station was labeled with a designation defining the transect number, sample number, and sample depth. An example of this nomenclature is the following: "UAS-T1-S1-0-0.5FT". "UAS" identifies that the sample matrix is soil and was collected from an undeveloped area. "T1" identifies the transect number, "S1" identifies the sample number, and "0-0.5FT" is the sampling interval. Note that the lower sample numbers correspond to samples closer to Dead Creek. For example, sample number 1 (or S1) is located near the edge of Dead Creek in all transects, S2 is approximately 200 feet from Dead Creek, and each consecutive sample number represents a sampling station that is 200 feet farther along the transect. S7 is located approximately 1,200 feet from Dead Creek. The shallow soil and subsurface soil sampling statistics and results in the undeveloped and developed areas (combined) are summarized in Tables 4-15 and 4-16, respectively. Color dot figures displaying the constituent concentrations at each sampling location are provided as Figures 4-35 through 4-44 for the

discrete surface samples, and Figures 4-45 through 4-54 for the vertically-integrated subsurface soil samples in the undeveloped areas.

#### **4.3.2 Developed Area Soil Sampling**

Twenty sampling stations were placed along seven transects in developed areas in Area 1. At each of these sampling stations, one surface sample and one subsurface soil were collected and analyzed for cyanide, dioxins, herbicides, mercury, metals, PCBs, pesticides, SVOCs, and VOCs. Each sampling station was labeled with similar designations as was used for the undeveloped areas (Section 4.3.1), except DAS (meaning developed area sample) replaced UAS. The shallow soil and vertically-integrated subsurface soil sampling statistics and results in the undeveloped and developed areas (combined) are summarized in Tables 4-15 and 4-16, respectively. Color dot figures displaying the constituent concentrations at each sampling location are shown on Figures 4-35 through 4-44 for the discrete surface samples, and Figures 4-45 through 4-54 for the vertically-integrated subsurface soil samples.

#### **4.3.3 Background Soil Sampling**

As discussed in Section 3.4.3, three shallow soil samples and three subsurface soil samples were collected near background monitor wells to establish background soil conditions in Area 1. The samples were numbered with nomenclature that defined the background well and sampling depth such as: BS-EE-20-0-0.5FT. The "BS" stands for background sample, "EE-20" identifies the background monitor well that the sample was collected near, and the remainder of the label identifies the sample depth. The results from the background sampling program are shown on Figures 4-35 through 4-54.

#### **4.4 Creek Segment Investigation Results**

The Creek Segment investigation involved collecting sediment samples from Area 1 Creek Segments CS-B through CS-F, in addition to three areas which are hydraulically connected to Dead Creek (Borrow Pit Lake, Old Prairie duPont Creek, and Site M). Sediment samples from these areas were analyzed for industry-specific constituents and broad-scan constituents.

The sediment sampling results from these two sets of parameters are discussed in the following subsections. The results are presented by reference to the corresponding color dot figures and data summary tables.

#### **4.4.1 Creek Segment Investigation (Industry-Specific Constituents)**

This section discusses the results of sampling and analysis for industry-specific constituents. These samples were collected from the undeveloped Creek Segments, developed Creek Segments, and the Borrow Pit Lake.

##### **4.4.1.1 Undeveloped Area Creek Sediments (CS-B and CS-F)**

Vertically integrated sediment core samples were collected at approximate 200-foot intervals in Creek Segments B and F as outlined in Section 3.5.1.1 of this document. The total approximate length of Creek Segments B and F is 10,000 feet, and 50 sediment samples were collected. Each sample was analyzed in an off-Site laboratory for the industry-specific constituents listed in the previous section.

The sediment samples were collected in Creek Segments B and F at the locations shown on Plate 4-1. Note that the sample locations are designated with a numbering system similar to the following: "FASED-CSB-S1-20IN". The "FASED" denotes "focused analysis sediment sample"; the "CSB" identifies the Creek Segment; the "S1" identifies the sediment sample number in the respective Creek Segment; and the "20IN" identifies the depth (in this case, 20 inches) from which the sample was collected. Some of the samples also have the directional symbol "N", "S", "E", or "W" next to the sample number (for example, S1W). The directional symbol identifies the side of Dead Creek from which the sample was collected. Ten sediment samples were collected from Creek Segment B, and 40 sediment samples were collected from Creek Segment F. The results from this sampling program are presented in Tables 4-17 and 4-18 for Creek Segments B and F, respectively, and are illustrated on color dot maps (Figures 4-55 through 4-59).



#### **4.4.1.2 Developed Area Creek Sediments (CS-C, CS-D and CS-E)**

Vertically integrated sediment core samples were collected at approximate 150-foot intervals in Creek Segments C, D and E as outlined in Section 3.5.1.2 of this document. The approximate combined length of these three Creek Segments is 7,000 feet, and 47 sediment samples were collected.

The sediment samples were collected in Creek Segments C, D, and E at the locations shown on Plate 4-1. Note that the sample locations in the developed Creek Segments are designated with the same numbering system as the samples collected in the undeveloped areas (i.e. 'FASED-CSC-S1-20IN'). For an explanation of this numbering system, refer to the previous section.

Twelve sediment samples were collected from Creek Segment C; nine samples were collected from Creek Segment D; 26 samples were collected from Creek Segment E. The results are presented in Tables 4-19, 4-20, and 4-21 for Creek Segments C, D and E, respectively. The results from these three creek segments are also illustrated on color dot maps (Figures 4-55 through 4-59).

#### **4.4.1.3 Borrow Pit Lake**

The Borrow Pit Lake is a 6,000-foot long body of water extending from the end of CS-F to a point just northwest of Dead Creek (Plate 4-1). The eight sediment samples collected from this lake start with sample number FASED-BPL-S1-0-10IN (or sampling station BPL1) at the northern end of the lake, and proceed southward on a 400-foot interval spacing with increasing sample numbers. The sample nomenclature is that same as described in Section 4.4.1.1; except that "BPL" stands for Borrow Pit Lake. The sample number FASED-BPL-S8-0-9IN (or sampling station BPL8) is the southernmost sample and is located approximately 1,200 feet north of the intersection of Borrow Pit Lake and Dead Creek (see Plate 4-1). The results from this sampling program are illustrated on color dot maps (Figures 4-55 through 4-59).

#### **4.4.2 Creek Segment Investigation Results (Broad-Scan Constituents)**

The samples analyzed for broad-scan constituents were collected from the undeveloped and developed Creek Segments, Site M, the Borrow Pit Lake, and the Old Prairie du Pont Creek.

##### **4.4.2.1 Dead Creek Sediments, Borrow Pit Lake and Reference Areas**

Three sediment samples were collected from each of the Creek Segments B, C, D, E, and F. In addition, three sediment samples were collected at the Borrow Pit Lake and from two reference areas. The nomenclature used to identify these samples is similar to the following: "SED-CSB-S1-0.2FT". This nomenclature is identical to the labels used for the industry specific constituents, except that the symbol "SED" (which stands for sediment) is used in place of "FASSED". The results from this sampling program are presented in Tables 4-17 through 4-21 (creek segments) and 4-22 (reference areas), and are illustrated on color dot figures (Figures 4-60 through 4-69).

##### **4.4.2.2 Site M and the Old Prairie du Pont Creek**

Site M is located along the eastern side of Dead Creek Segment B and south of Site L. Site M was originally used as a sand borrow pit and is connected to Dead Creek through an opening at the southwest corner of the site. One sample was collected from Site M and is labeled "SED-M-S1-0.2FT". The nomenclature "SED" identifies a sediment sample; "M" designates Site M, "S1" designates the sample number, and "0.2 FT" identifies the sample depth.

The Old Prairie duPont Creek is located at the southern (downstream) end of Creek Segment F and routes all of the water from Dead Creek to the Mississippi River. To evaluate the impact of the Dead Creek discharge on sediment quality in Old Prairie duPont Creek, one sample was collected upstream and one sample was collected downstream of the confluence of Dead Creek and Old Prairie duPont Creek. The two sediment samples that were collected from this Creek Segment are numbered in the following manner: BSSSED-PDC-S-0-30IN and BSSSED-PDC-N-O-20IN. The nomenclature "BSSSED" identifies the sampling parameters as

broad scan sediments; the "PDC" identifies that the sample was collected at Old Prairie duPont Creek; the "N" and "S" identify that the sample was collected north and south of the Old Prairie duPont Creek and Dead Creek intersection, respectively; and the "0-20IN" identifies the sampling interval.

The sample results from Site M and the Old Prairie du Pont Creek are presented in Tables 4-23 (Site M), and 4-24 (Old Prairie du Pont Creek), and are illustrated on color dot figures (Figures 4-60 through 4-69).

#### **4.5 Surface-Water Investigation Results**

Surface-water sampling was conducted at Dead Creek, Site M, the Borrow Pit Lake, Old Prairie duPont Creek and two reference areas to determine the downstream concentrations of Site-related constituents. Twenty surface-water samples were collected and analyzed for VOCs, SVOCs, PCBs, pesticides and herbicides, dioxins, metals and miscellaneous, general water-quality parameters. Sufficient water was not available to sample three of the stations in CS-C and two of the stations in CS-E. Analytical results are summarized in Tables 4-25 through 4-28 (Dead Creek), Table 4-29 (Site M), Table 4-30 (Old Prairie duPont Creek), and Table 4-31 (Reference Areas). Color dot maps displaying the constituent concentrations at each sampling location are provided as Figures 4-70 through 4-79.

#### **4.6 Air Investigation Results**

Upwind and downwind air sampling was performed at Sites G, H, I and L to determine the concentrations of VOCs, SVOCs, PCBs, dioxins and metals upwind and downwind from fill areas. Sampling results are summarized on color dot maps (Figures 4-80 through 4-87) and are presented in Tables 4-32 (upwind) and 4-33 (downwind). Data provided in the figures are presented on a mass analyzed per sampling device basis and are converted to mass per cubic meter of sample air volume in the Tables.

#### **4.7 Ecological Risk Assessment**

In addition to sediment and shallow soil samples, biota samples were collected from Creek Segment F, the Borrow Pit Lake and Reference Areas to support the ERA. Two samples each of creepy buttercup were collected from CS-F and Reference Areas. Three composite freshwater clam samples each were collected from the Borrow Pit Lake and Reference Areas. One composite shrimp sample was collected from Borrow Pit Lake; two composite shrimp samples were collected from the Reference Areas. Fish samples included: three composite largemouth bass samples from the Bottom Pit Lake and two each from the Reference Areas; three composite brown bullhead samples from the Borrow Pit Lake and three from the Reference Areas; and three composite forage fish samples from the Borrow Pit Lake and four from the Reference Areas. Analytical results are summarized in Tables 4-34 through 4-41.

#### **4.8 Treatability Study Results**

As discussed in Section 3.9, treatability studies completed as part of the SSP were limited to pilot tests to evaluate potential treatment technologies for fill area leachate. The purpose of the testing was to screen the feasibility of technically sound, operationally reliable and cost-effective technologies for treating the Area 1 leachate in the event such leachate requires removal, treatment and subsequent discharge to the American Bottoms Regional Treatment Facility.

Twenty-five gallons of leachate were collected from both Site G and Site I and shipped to the Advent Group, Inc.'s (Advent's) treatability testing laboratory in Nashville, Tennessee. The Site G and I samples were subsequently composited into a 55-gallon drum and sampled for characterization purposes. The combined leachate sample characterization data confirmed and quantified the presence of individual COPCs. All leachate characterization data and treatability testing results are presented in Advent's November 2000 report titled *Sauget Area 1, EE/CA-R/FS Support Sampling Plan, Leachate Treatability Tests*.

Treatment technology test methods employed by Advent were as follow:

**Treatment Technology**

**Batch Test Method**

Chemical precipitation using lime and caustic

Jar tests

Oxidation with hydrogen peroxide and ozone

Jar tests

Filtration

Filtration at various pore sizes

Activated carbon adsorption

Isotherm and column tests

Biological treatment

Batch tests

Treatment test results are summarized as follow:

- Metals can be effectively removed by pH adjustment and chemical precipitation.
- PCBs and total suspended solids can be effectively removed by filtration.
- Activated carbon adsorption can effectively remove PCBs, herbicides, SVOCs, VOCs and dioxins; however, total TOC loadings and adsorption rates indicate rapid column exhaustion rendering the technology more suitable as a final polishing step.
- Biological treatment (activated sludge) and oxidation (hydrogen peroxide or ozone) appear to be technically feasible options for treating the organics in the leachate.

**Table 4-1**  
**Fill Area Discrete Surface Sample Summary - Site G**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
G	Waste	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.00	0.00	0.01	0.01
G	Waste	Aluminum	mg/kg dw	4	100%	4	8300.00	12850.00	15000.00	15000.00
G	Waste	Iron	mg/kg dw	4	100%	4	16000.00	18375.00	20000.00	20000.00
G	Waste	Lead	mg/kg dw	4	100%	4	11.00	13.63	16.00	16.00
G	Waste	Magnesium	mg/kg dw	4	100%	4	3300.00	4087.50	4950.00	4950.00
G	Waste	Manganese	mg/kg dw	4	100%	4	260.00	543.75	740.00	740.00
G	Waste	Mercury	mg/kg dw	4	100%	4	0.02	0.02	0.03	0.03
G	Waste	Molybdenum	mg/kg dw	4	100%	4	0.38	0.52	0.78	0.78
G	Waste	Nickel	mg/kg dw	4	100%	4	17.00	18.88	21.50	21.50
G	Waste	Potassium	mg/kg dw	4	100%	4	1200.00	1450.00	1700.00	1700.00
G	Waste	Antimony	mg/kg dw	4	50%	2	0.85	0.89	0.72	0.72
G	Waste	Arsenic	mg/kg dw	4	100%	4	6.50	7.19	8.05	8.05
G	Waste	Barium	mg/kg dw	4	100%	4	79.00	117.25	140.00	140.00
G	Waste	Beryllium	mg/kg dw	4	100%	4	0.51	0.59	0.64	0.64
G	Waste	Cadmium	mg/kg dw	4	100%	4	0.18	0.26	0.39	0.39
G	Waste	Chromium	mg/kg dw	4	100%	4	15.00	19.25	22.00	22.00
G	Waste	Cobalt	mg/kg dw	4	100%	4	5.80	7.33	8.60	8.60
G	Waste	Copper	mg/kg dw	4	100%	4	100.00	182.50	280.00	290.00
G	Waste	Vanadium	mg/kg dw	4	100%	4	32.00	36.75	40.00	40.00
G	Waste	Zinc	mg/kg dw	4	100%	4	56.00	60.88	69.50	69.50
G	Waste	Calcium	mg/kg dw	4	100%	4	5100.00	8725.00	14000.00	14000.00
G	Waste	Total PCBs	ug/kg dw	4	50%	4	7.90	18.10	46.50	46.50
G	Waste	Heptachlor epoxide	ug/kg dw	4	25%	1	0.22	0.22	0.22	0.22
G	Waste	Endosulfan sulfate	ug/kg dw	4	50%	2	0.12	0.15	0.18	0.18
G	Waste	delta-BHC	ug/kg dw	4	75%	3	0.06	0.10	0.18	0.18
G	Waste	Endosulfan II	ug/kg dw	4	25%	1	0.34	0.34	0.34	0.34
G	Waste	4,4'-DDT	ug/kg dw	4	75%	3	0.08	0.11	0.16	0.16
G	Waste	Alpha Chlordane	ug/kg dw	4	50%	2	0.12	0.19	0.28	0.28
G	Waste	Gamma Chlordane	ug/kg dw	4	75%	3	0.08	0.20	0.31	0.31
G	Waste	Endrin ketone	ug/kg dw	4	50%	2	0.79	0.91	1.03	1.03
G	Waste	Dieldrin	ug/kg dw	4	25%	1	0.06	0.06	0.06	0.06
G	Waste	Endrin	ug/kg dw	4	50%	2	0.14	0.15	0.16	0.16
G	Waste	Methoxychlor	ug/kg dw	4	25%	1	0.94	0.94	0.94	0.94
G	Waste	Endrin aldehyde	ug/kg dw	4	50%	2	0.12	0.40	0.67	0.67
G	Waste	Endosulfan I	ug/kg dw	4	25%	1	0.22	0.22	0.22	0.22

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-2 (1 of 2)  
Fill Area Discrete Surface Sample Summary - Site H

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
H	Waste	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.03	0.53	1.29	1.29
H	Waste	2,4-DB	ug/kg dw	4	50%	4	4.30	6.74	9.70	9.70
H	Waste	Aluminum	mg/kg dw	4	100%	4	4300.00	7950.00	14000.00	14000.00
H	Waste	Iron	mg/kg dw	4	100%	4	14000.00	16250.00	18000.00	18000.00
H	Waste	Lead	mg/kg dw	4	100%	4	53.00	145.75	230.00	230.00
H	Waste	Magnesium	mg/kg dw	4	100%	4	690.00	2022.50	2500.00	2500.00
H	Waste	Manganese	mg/kg dw	4	100%	4	98.00	437.00	720.00	720.00
H	Waste	Mercury	mg/kg dw	4	100%	4	0.06	0.28	0.77	0.77
H	Waste	Molybdenum	mg/kg dw	4	100%	4	0.98	4.95	11.00	11.00
H	Waste	Nickel	mg/kg dw	4	100%	4	20.00	34.00	70.00	70.00
H	Waste	Potassium	mg/kg dw	4	100%	4	830.00	1157.50	1600.00	1600.00
H	Waste	Silver	mg/kg dw	4	75%	4	0.51	1.39	2.70	2.64
H	Waste	Sodium	mg/kg dw	4	100%	4	110.00	247.50	390.00	390.00
H	Waste	Thallium	mg/kg dw	4	25%	4	0.47	1.01	2.50	2.50
H	Waste	Antimony	mg/kg dw	4	100%	4	0.69	1.57	2.30	2.30
H	Waste	Arsenic	mg/kg dw	4	100%	4	6.50	22.75	64.00	64.00
H	Waste	Barium	mg/kg dw	4	100%	4	99.00	112.25	120.00	120.00
H	Waste	Beryllium	mg/kg dw	4	100%	4	0.73	1.52	3.80	3.80
H	Waste	Cadmium	mg/kg dw	4	100%	4	2.70	9.03	22.00	22.00
H	Waste	Chromium	mg/kg dw	4	100%	4	15.00	19.50	23.00	23.00
H	Waste	Cobalt	mg/kg dw	4	100%	4	5.20	10.03	20.00	20.00
H	Waste	Copper	mg/kg dw	4	100%	4	200.00	375.00	480.00	480.00
H	Waste	Vanadium	mg/kg dw	4	100%	4	20.00	30.00	45.00	45.00
H	Waste	Zinc	mg/kg dw	4	100%	4	350.00	1280.00	3600.00	3600.00
H	Waste	Calcium	mg/kg dw	4	100%	4	5900.00	17600.00	42000.00	42000.00
H	Waste	Selenium	mg/kg dw	4	75%	4	0.42	1.58	4.70	4.70
H	Waste	Total PCBs	ug/kg dw	4	75%	4	8.50	680.38	1519.00	1519.00
H	Waste	Heptachlor epoxide	ug/kg dw	4	75%	4	0.59	16.39	44.00	44.00
H	Waste	Aldrin	ug/kg dw	4	50%	4	0.90	8.21	21.00	19.44
H	Waste	Endosulfan II	ug/kg dw	4	25%	3	1.70	3.57	7.20	7.20
H	Waste	4,4'-DDT	ug/kg dw	4	75%	4	1.70	45.10	110.00	110.00
H	Waste	Gamma Chlordane	ug/kg dw	4	50%	4	0.90	14.71	30.00	30.00
H	Waste	Endrin ketone	ug/kg dw	4	75%	4	1.40	25.03	82.00	82.00
H	Waste	Methoxychlor	ug/kg dw	4	50%	4	9.00	45.38	130.00	130.00
H	Waste	4,4'-DDE	ug/kg dw	4	75%	4	1.70	34.40	86.00	86.00
H	Waste	Heptachlor	ug/kg dw	4	25%	3	0.90	1.28	2.00	2.00

NOTE: Site concentration is the average of the four samples.

**Table 4-2 (2 of 2)**  
**Fill Area Discrete Surface Sample Summary - Site H**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
H	Waste	bis(2-Ethylhexyl)phthalate	ug/kg dw	4	50%	4	90.00	103.75	120.00	120.00
H	Waste	Pyrene	ug/kg dw	4	75%	4	90.00	157.50	190.00	190.00
H	Waste	Benzo(g,h,i)perylene	ug/kg dw	4	25%	4	90.00	161.25	370.00	370.00
H	Waste	Indeno(1,2,3-cd)pyrene	ug/kg dw	4	50%	4	87.00	91.75	100.00	100.00
H	Waste	Benzo(b)fluoranthene	ug/kg dw	4	75%	4	80.00	112.50	140.00	140.00
H	Waste	Fluoranthene	ug/kg dw	4	75%	4	90.00	170.00	240.00	240.00
H	Waste	Benzo(k)fluoranthene	ug/kg dw	4	75%	4	82.00	96.75	130.00	130.00
H	Waste	Chrysene	ug/kg dw	4	75%	4	90.00	157.50	300.00	300.00
H	Waste	Benzo(a)anthracene	ug/kg dw	4	75%	4	47.00	99.25	140.00	140.00
H	Waste	Phenanthrene	ug/kg dw	4	25%	4	90.00	103.75	130.00	130.00
H	Waste	Pentachlorophenol	ug/kg dw	4	25%	4	224.50	231.63	240.50	240.50
H	Waste	Tetrachloroethene	ug/kg dw	4	25%	4	2.55	6.73	17.00	17.00
H	Waste	2-Hexanone	ug/kg dw	4	25%	1	5.70	5.70	5.70	5.70
H	Waste	Carbon disulfide	ug/kg dw	4	25%	3	2.55	3.42	4.30	4.30

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.



Table 4-3 (1 of 2)  
Fill Area Discrete Surface Sample Summary - Site I

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
I	Waste	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.07	3.34	12.68	12.68
I	Waste	2,4-DB	ug/kg dw	4	25%	3	4.35	12.66	29.13	29.13
I	Waste	Aluminum	mg/kg dw	4	100%	4	3750.00	5637.50	8000.00	8000.00
I	Waste	Iron	mg/kg dw	4	100%	4	5350.00	10837.50	16000.00	16000.00
I	Waste	Lead	mg/kg dw	4	100%	4	220.00	695.00	1500.00	1410.13
I	Waste	Magnesium	mg/kg dw	4	100%	4	7600.00	12400.00	19000.00	19000.00
I	Waste	Manganese	mg/kg dw	4	100%	4	160.00	202.50	300.00	300.00
I	Waste	Mercury	mg/kg dw	4	100%	4	0.05	0.80	2.00	2.00
I	Waste	Molybdenum	mg/kg dw	4	100%	4	2.70	5.86	8.50	8.50
I	Waste	Nickel	mg/kg dw	4	100%	4	14.50	35.39	65.00	65.00
I	Waste	Potassium	mg/kg dw	4	100%	4	1050.00	1237.50	1500.00	1500.00
I	Waste	- Silver	mg/kg dw	4	100%	4	1.75	6.71	19.00	19.00
I	Waste	Sodium	mg/kg dw	4	100%	4	440.00	635.00	870.00	870.00
I	Waste	Antimony	mg/kg dw	4	100%	4	2.90	6.08	8.40	8.40
I	Waste	Arsenic	mg/kg dw	4	100%	4	4.55	7.79	12.00	12.00
I	Waste	Barium	mg/kg dw	4	100%	4	83.00	280.75	740.00	740.00
I	Waste	Beryllium	mg/kg dw	4	100%	4	0.46	0.91	1.70	1.70
I	Waste	Cadmium	mg/kg dw	4	100%	4	2.20	11.20	31.00	31.00
I	Waste	Chromium	mg/kg dw	4	100%	4	13.00	33.25	65.00	65.00
I	Waste	Cobalt	mg/kg dw	4	100%	4	2.00	12.05	33.00	33.00
I	Waste	Copper	mg/kg dw	4	100%	4	1850.00	6662.50	13000.00	13000.00
I	Waste	Vanadium	mg/kg dw	4	100%	4	10.70	18.88	26.00	26.00
I	Waste	Zinc	mg/kg dw	4	100%	4	405.00	1426.25	2800.00	2800.00
I	Waste	Calcium	mg/kg dw	4	100%	4	82000.00	156750.00	235000.00	235000.00
I	Waste	Selenium	mg/kg dw	4	75%	4	0.55	1.10	1.60	1.60
I	Waste	Total PCBs	ug/kg dw	4	75%	4	61.00	31268.75	121260.00	121260.00
I	Waste	Heptachlor epoxide	ug/kg dw	3	100%	3	0.94	48.55	140.00	140.00
I	Waste	Endosulfan sulfate	ug/kg dw	3	33%	2	8.50	8.65	8.80	8.80
I	Waste	Aldrin	ug/kg dw	3	100%	3	0.82	84.77	250.00	250.00
I	Waste	Endosulfan II	ug/kg dw	3	100%	3	2.25	205.75	600.00	600.00
I	Waste	4,4'-DDT	ug/kg dw	3	67%	3	2.50	157.17	460.00	460.00
I	Waste	Alpha Chlordane	ug/kg dw	3	33%	1	2.65	2.65	2.65	2.65
I	Waste	Gamma Chlordane	ug/kg dw	3	100%	3	5.55	131.52	380.00	380.00
I	Waste	Endrin ketone	ug/kg dw	3	100%	3	3.20	241.73	700.00	700.00
I	Waste	Dieldrin	ug/kg dw	3	100%	3	1.70	70.43	200.00	200.00
I	Waste	Endrin	ug/kg dw	3	100%	3	0.91	82.24	240.00	240.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-3 (2 of 2)**  
**Fill Area Discrete Surface Sample Summary - Site 1**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
1	Waste	Methoxychlor	ug/kg dw	3	100%	3	16.00	1027.67	3000.00	3000.00
1	Waste	4,4'-DDD	ug/kg dw	3	100%	3	0.31	66.91	200.00	200.00
1	Waste	4,4'-DDE	ug/kg dw	3	100%	3	1.55	102.98	300.00	300.00
1	Waste	Endrin aldehyde	ug/kg dw	3	100%	3	4.70	514.90	1500.00	1500.00
1	Waste	Heptachlor	ug/kg dw	3	67%	3	0.86	24.80	69.00	69.00
1	Waste	Endosulfan I	ug/kg dw	3	100%	3	0.72	88.81	260.00	260.00
1	Waste	1,4-Dichlorobenzene	ug/kg dw	4	25%	1	46.00	46.00	46.00	46.00
1	Waste	4-Chloroaniline	ug/kg dw	4	50%	4	165.00	464.75	1800.00	1800.00
1	Waste	bis(2-Ethylhexyl)phthalate	ug/kg dw	4	25%	1	87.50	87.50	87.50	87.50
1	Waste	Hexachlorobenzene	ug/kg dw	4	25%	4	35.25	54.81	110.00	110.00
1	Waste	Anthracene	ug/kg dw	4	50%	4	28.50	235.88	730.00	730.00
1	Waste	1,2,4-Trichlorobenzene	ug/kg dw	4	25%	4	85.00	111.25	180.00	180.00
1	Waste	2,4-Dichlorophenol	ug/kg dw	4	25%	1	82.00	82.00	82.00	82.00
1	Waste	Pyrene	ug/kg dw	4	100%	4	140.00	1348.75	4700.00	4700.00
1	Waste	Dibenzofuran	ug/kg dw	4	25%	4	85.00	92.50	100.00	100.00
1	Waste	Benzo(g,h,i)perylene	ug/kg dw	4	75%	4	90.00	486.25	1600.00	1600.00
1	Waste	Indeno(1,2,3-cd)pyrene	ug/kg dw	4	50%	4	90.00	483.75	1600.00	1600.00
1	Waste	Benzo(b)fluoranthene	ug/kg dw	4	75%	4	95.00	813.75	2800.00	2800.00
1	Waste	Fluoranthene	ug/kg dw	4	100%	4	120.00	1663.75	6000.00	6000.00
1	Waste	Benzo(k)fluoranthene	ug/kg dw	4	75%	4	55.00	310.25	960.00	960.00
1	Waste	Chrysene	ug/kg dw	4	75%	4	95.00	662.25	2200.00	2200.00
1	Waste	Benzo(a)pyrene	ug/kg dw	4	75%	4	49.50	628.63	2200.00	2200.00
1	Waste	Dibenzo(a,h)anthracene	ug/kg dw	4	50%	4	36.50	123.13	360.00	360.00
1	Waste	Benzo(a)anthracene	ug/kg dw	4	75%	4	78.00	653.25	2200.00	2200.00
1	Waste	Di-n-butylphthalate	ug/kg dw	4	25%	1	52.00	52.00	52.00	52.00
1	Waste	Phenanthrene	ug/kg dw	4	100%	4	50.00	879.63	3300.00	3300.00
1	Waste	Fluorene	ug/kg dw	4	25%	4	85.00	125.00	230.00	230.00
1	Waste	Carbazole	ug/kg dw	4	25%	4	85.00	147.50	320.00	320.00
1	Waste	Pentachlorophenol	ug/kg dw	4	100%	4	220.31	633.77	1650.00	1650.00
1	Waste	2-Nitroaniline	ug/kg dw	4	25%	1	160.00	160.00	160.00	160.00
1	Waste	Toluene	ug/kg dw	4	25%	4	2.35	2.89	3.30	3.30

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-4 (1 of 2)**  
**Fill Area Discrete Surface Sample Summary - Site L**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
L	Waste	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.09	0.38	0.82	0.82
L	Waste	Cyanide, Total	mg/kg dw	4	25%	4	0.27	0.81	1.60	1.60
L	Waste	Aluminum	mg/kg dw	4	100%	4	3500.00	5750.00	7600.00	7600.00
L	Waste	Iron	mg/kg dw	4	100%	4	7100.00	23025.00	32000.00	32000.00
L	Waste	Lead	mg/kg dw	4	100%	4	64.00	368.50	940.00	940.00
L	Waste	Magnesium	mg/kg dw	4	100%	4	340.00	2485.00	4200.00	4200.00
L	Waste	Manganese	mg/kg dw	4	100%	4	23.00	350.75	650.00	650.00
L	Waste	Mercury	mg/kg dw	4	100%	4	0.04	0.32	0.56	0.56
L	Waste	Molybdenum	mg/kg dw	4	100%	4	9.30	14.48	23.00	23.00
L	Waste	Nickel	mg/kg dw	4	100%	4	38.00	48.75	55.00	55.00
L	Waste	Potassium	mg/kg dw	4	100%	4	500.00	1087.50	1700.00	1678.58
L	Waste	Silver	mg/kg dw	4	75%	4	0.55	0.81	1.20	1.20
L	Waste	Sodium	mg/kg dw	4	100%	4	210.00	345.00	540.00	540.00
L	Waste	Thallium	mg/kg dw	4	100%	4	1.60	1.85	2.10	2.09
L	Waste	Antimony	mg/kg dw	4	100%	4	2.00	3.28	5.40	5.40
L	Waste	Arsenic	mg/kg dw	4	100%	4	30.00	33.25	37.00	37.00
L	Waste	Barium	mg/kg dw	4	100%	4	83.00	170.75	250.00	250.00
L	Waste	Beryllium	mg/kg dw	4	100%	4	1.40	1.48	1.60	1.60
L	Waste	Cadmium	mg/kg dw	4	100%	4	0.71	5.60	10.00	10.00
L	Waste	Chromium	mg/kg dw	4	100%	4	17.00	45.25	79.00	78.00
L	Waste	Cobalt	mg/kg dw	4	100%	4	11.00	13.75	17.00	17.00
L	Waste	Copper	mg/kg dw	4	100%	4	190.00	1782.50	4700.00	4700.00
L	Waste	Vanadium	mg/kg dw	4	100%	4	39.00	44.25	49.00	49.00
L	Waste	Zinc	mg/kg dw	4	100%	4	160.00	510.00	870.00	860.77
L	Waste	Calcium	mg/kg dw	4	100%	4	2800.00	19950.00	29000.00	29000.00
L	Waste	Selenium	mg/kg dw	4	100%	4	1.80	3.08	4.30	4.30
L	Waste	Total PCBs	ug/kg dw	4	50%	4	9.00	489.50	1171.00	1065.51
L	Waste	Heptachlor epoxide	ug/kg dw	4	75%	4	0.90	5.85	9.20	9.20
L	Waste	Aldrin	ug/kg dw	4	25%	4	0.90	3.83	5.50	5.50
L	Waste	beta-BHC	ug/kg dw	4	25%	4	0.25	1.66	3.70	3.70
L	Waste	4,4'-DDT	ug/kg dw	4	25%	4	1.80	8.95	16.00	15.77
L	Waste	Gamma Chlordane	ug/kg dw	4	75%	4	0.90	11.48	21.00	21.00
L	Waste	Endrin ketone	ug/kg dw	4	75%	4	1.80	12.30	28.00	28.00
L	Waste	Dieldrin	ug/kg dw	4	25%	4	1.80	7.83	12.00	12.00
L	Waste	Methoxychlor	ug/kg dw	4	50%	3	9.00	26.33	46.00	46.00
L	Waste	4,4'-DDE	ug/kg dw	4	75%	4	1.80	10.95	20.00	19.75

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-4 (2 of 2)**  
**Fill Area Discrete Surface Sample Summary - Site L**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
L	Waste	bis(2-Ethylhexyl)phthalate	ug/kg dw	4	50%	4	90.00	190.00	310.00	310.00
L	Waste	Anthracene	ug/kg dw	4	75%	4	90.00	1052.50	3600.00	3600.00
L	Waste	Pyrene	ug/kg dw	4	75%	4	90.00	4272.50	13000.00	13000.00
L	Waste	Dibenzofuran	ug/kg dw	4	25%	4	90.00	256.25	750.00	750.00
L	Waste	Benzofluoranthene	ug/kg dw	4	75%	4	90.00	1332.50	3800.00	3800.00
L	Waste	Indeno(1,2,3-cd)pyrene	ug/kg dw	4	75%	4	90.00	1577.50	4800.00	4800.00
L	Waste	Benzofluoranthene	ug/kg dw	4	75%	4	90.00	2192.50	6600.00	6600.00
L	Waste	Fluoranthene	ug/kg dw	4	75%	4	90.00	5772.50	18000.00	18000.00
L	Waste	Benzofluoranthene	ug/kg dw	4	75%	4	90.00	2287.50	6800.00	6800.00
L	Waste	Chrysene	ug/kg dw	4	75%	4	90.00	2637.50	7800.00	7800.00
L	Waste	Benzofluoranthene	ug/kg dw	4	75%	4	90.00	2299.75	7000.00	7000.00
L	Waste	Benzofluoranthene	ug/kg dw	4	75%	4	49.00	454.75	1300.00	1300.00
L	Waste	Dibenzofluoranthene	ug/kg dw	4	50%	4	90.00	2557.50	7800.00	7800.00
L	Waste	Acenaphthene	ug/kg dw	4	50%	4	90.00	481.25	1600.00	1600.00
L	Waste	Phenanthrene	ug/kg dw	4	75%	4	90.00	3622.50	12000.00	12000.00
L	Waste	Fluorene	ug/kg dw	4	50%	4	90.00	421.25	1400.00	1400.00
L	Waste	Carbazole	ug/kg dw	4	75%	4	90.00	480.00	1500.00	1500.00
L	Waste	Pentachlorophenol	ug/kg dw	4	25%	3	234.50	238.08	240.00	240.00
L	Waste	Naphthalene	ug/kg dw	4	25%	4	90.00	148.75	320.00	320.00
L	Waste	2-Methylnaphthalene	ug/kg dw	4	25%	4	90.00	103.75	140.00	140.00
L	Waste	Toluene	ug/kg dw	4	25%	4	3.15	6.08	13.00	13.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4 of 2  
Fill Area Discrete Surface Sample Summary - Site N

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
N	Waste	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.0039040	0.0976385	0.3445100	0.3445100
N	Waste	Aluminum	mg/kg dw	4	100%	4	7500.0000	8750.0000	11000.0000	11000.0000
N	Waste	Iron	mg/kg dw	4	100%	4	13000.0000	14250.0000	15000.0000	15000.0000
N	Waste	Lead	mg/kg dw	4	100%	4	19.0000	138.1250	410.0000	410.0000
N	Waste	Magnesium	mg/kg dw	4	100%	4	5200.0000	7175.0000	11500.0000	11500.0000
N	Waste	Manganese	mg/kg dw	4	100%	4	280.0000	373.7500	410.0000	410.0000
N	Waste	Mercury	mg/kg dw	4	100%	4	0.0310	0.0678	0.0950	0.0950
N	Waste	Molybdenum	mg/kg dw	4	100%	4	0.7000	1.0275	1.4500	1.4500
N	Waste	Nickel	mg/kg dw	4	100%	4	15.0000	16.1250	17.0000	17.0000
N	Waste	Potassium	mg/kg dw	4	100%	4	1200.0000	1400.0000	1600.0000	1600.0000
N	Waste	Antimony	mg/kg dw	4	25%	1	0.7100	0.7100	0.7100	0.7100
N	Waste	Arsenic	mg/kg dw	4	100%	4	5.5000	6.3250	7.3000	7.3000
N	Waste	Barium	mg/kg dw	4	100%	4	140.0000	592.5000	1200.0000	1200.0000
N	Waste	Cadmium	mg/kg dw	4	100%	4	0.3000	0.8463	1.5000	1.5000
N	Waste	Chromium	mg/kg dw	4	100%	4	12.0000	16.5000	18.0000	18.0000
N	Waste	Cobalt	mg/kg dw	4	100%	4	5.6000	5.8375	6.1500	6.1500
N	Waste	Copper	mg/kg dw	4	100%	4	16.0000	50.1250	110.0000	110.0000
N	Waste	Vanadium	mg/kg dw	4	100%	4	21.0000	23.7500	29.0000	29.0000
N	Waste	Zinc	mg/kg dw	4	100%	4	62.0000	149.2500	250.0000	250.0000
N	Waste	Calcium	mg/kg dw	4	100%	4	16000.0000	57250.0000	108000.0000	108000.0000
N	Waste	Selenium	mg/kg dw	4	25%	4	0.4950	0.5888	0.6800	0.6800
N	Waste	Total PCBs	ug/kg dw	4	25%	4	9.0000	51.3125	178.0000	178.0000
N	Waste	Aldrin	ug/kg dw	4	25%	3	0.9000	1.0250	1.2750	1.2750
N	Waste	beta-BHC	ug/kg dw	4	25%	3	0.2700	0.2925	0.3375	0.3375
N	Waste	4,4'-DDT	ug/kg dw	4	25%	4	1.7500	2.0188	2.7000	2.7000
N	Waste	Alpha Chlordane	ug/kg dw	4	25%	3	0.9000	0.9897	1.1000	1.1000
N	Waste	Gamma Chlordane	ug/kg dw	4	25%	4	0.9000	1.3750	1.8500	1.8500
N	Waste	Dieldrin	ug/kg dw	4	25%	3	1.7500	1.8917	2.1250	2.1250
N	Waste	Methoxychlor	ug/kg dw	4	25%	4	9.0000	20.6250	55.0000	55.0000
N	Waste	bis(2-Ethylhexyl)phthalate	ug/kg dw	4	25%	4	80.0000	101.2500	130.0000	130.0000
N	Waste	Anthracene	ug/kg dw	4	75%	3	36.0000	47.0000	58.0000	58.0000
N	Waste	Pyrene	ug/kg dw	4	100%	4	150.0000	341.2500	550.0000	550.0000
N	Waste	Benzo(g,h,i)perylene	ug/kg dw	4	25%	4	80.0000	143.7500	300.0000	300.0000
N	Waste	Indeno(1,2,3-cd)pyrene	ug/kg dw	4	75%	4	87.5000	144.3750	250.0000	250.0000
N	Waste	Benzo(b)fluoranthene	ug/kg dw	4	100%	4	59.0000	164.7500	320.0000	320.0000
N	Waste	Fluoranthene	ug/kg dw	4	100%	4	170.0000	392.5000	610.0000	610.0000

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-5 (c of 2)

## Fill Area Discrete Surface Sample Summary - Site N

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
N	Waste	Benzofluoranthene	ug/kg dw	4	100%	4	80.0000	217.5000	360.0000	360.0000
N	Waste	Chrysene	ug/kg dw	4	100%	4	88.0000	199.5000	310.0000	310.0000
N	Waste	Benzofluoranthene	ug/kg dw	4	100%	4	72.0000	187.2500	330.0000	330.0000
N	Waste	Dibenzofluoranthene	ug/kg dw	4	50%	4	49.0000	72.5000	110.0000	108.7183
N	Waste	Benzofluoranthene	ug/kg dw	4	100%	4	70.0000	168.3750	270.0000	270.0000
N	Waste	Phenanthrene	ug/kg dw	4	100%	4	80.0000	176.2500	260.0000	260.0000
N	Waste	Pentachlorophenol	ug/kg dw	4	100%	4	232.0000	306.9875	473.8000	473.8000

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

**Table 4**  
**Fill Area Composite Sample Summary - Site G**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
G	Waste TCLP	1998 Total TEQ w/ EMPC as ND	ug/L	4	100%	4	0.00	0.01	0.03	0.03
G	Waste TCLP	2,4-D	mg/l	4	75%	4	0.04	13.18	50.00	50.00
G	Waste TCLP	Lead	mg/l	4	50%	4	0.10	8.09	24.00	24.00
G	Waste TCLP	Barium	mg/l	4	100%	4	1.05	2.94	5.30	5.30
G	Waste TCLP	Cadmium	mg/l	4	25%	4	0.05	0.07	0.12	0.11
G	Waste TCLP	Cyanide, Total	mg/kg dw	4	50%	4	0.31	1.50	2.80	2.80
G	Waste TCLP	pH	su	4	100%	4	3.50	6.81	8.85	8.85
G	Waste TCLP	Corrosivity-pH	units	4	100%	4	3.18	6.80	8.70	8.70
G	Waste TCLP	Total PCBs	ug/kg dw	4	100%	4	12855.00	111756.25	324370.00	324370.00
G	Waste TCLP	gamma-BHC (Lindane)	mg/l	4	25%	4	0.00	0.00	0.00	0.00
G	Waste TCLP	1,4-Dichlorobenzene	mg/l	4	75%	4	0.03	0.11	0.22	0.22
G	Waste TCLP	Cresol m & p (TCLP)	mg/l	4	50%	4	0.03	0.07	0.14	0.13
G	Waste TCLP	Cresol o,m,p (TCLP)	mg/l	4	50%	4	0.03	0.08	0.19	0.17
G	Waste TCLP	Pentachlorophenol	mg/l	4	25%	4	0.13	0.46	1.10	1.10
G	Waste TCLP	2,4,6-Trichlorophenol	mg/l	4	50%	4	0.01	1.27	4.95	4.95
G	Waste TCLP	2-Methylphenol (o-cresol)	mg/l	4	50%	4	0.01	0.03	0.06	0.06
G	Waste TCLP	Nitrobenzene	mg/l	4	75%	4	0.02	0.04	0.07	0.07
G	Waste TCLP	Chlorobenzene	mg/l	4	75%	4	0.01	0.82	2.70	2.70
G	Waste TCLP	Tetrachloroethene	mg/l	4	75%	4	0.01	0.04	0.13	0.13
G	Waste TCLP	Benzene	mg/l	4	75%	4	0.01	0.20	0.80	0.80
G	Waste TCLP	2-Butanone (MEK)	mg/l	4	25%	4	0.05	0.07	0.12	0.11
G	Waste TCLP	Trichloroethene	mg/l	4	100%	4	0.00	0.02	0.08	0.08

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-7

## Fill Area Composite Sample Summary - Site H

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
H	Waste TCLP	1998 Total TEQ w/ EMPC as ND	ug/L	5	100%	5	0.00	0.00	0.00	0.00
H	Waste TCLP	2,4-D	mg/l	5	40%	5	0.01	0.09	0.42	0.42
H	Waste TCLP	Lead	mg/l	5	60%	5	0.10	8.19	40.00	40.00
H	Waste TCLP	Arsenic	mg/l	5	20%	5	0.10	0.17	0.45	0.45
H	Waste TCLP	Cadmium	mg/l	5	60%	5	0.05	4.52	22.00	22.00
H	Waste TCLP	Total Releasable Sulfide	mg H2S/kg	5	20%	5	25.00	166.00	730.00	468.59
H	Waste TCLP	pH	su	5	100%	5	5.80	7.08	7.80	7.80
H	Waste TCLP	Corrosivity-pH	units	5	100%	5	6.02	7.10	7.63	7.63
H	Waste TCLP	Total PCBs	ug/kg dw	5	100%	5	72.20	298488.44	1180800.00	1180800.00
H	Waste TCLP	1,4-Dichlorobenzene	mg/l	5	40%	5	0.03	0.36	1.80	1.80
H	Waste TCLP	Cresol m & p (TCLP)	mg/l	5	40%	5	0.01	0.11	0.48	0.48
H	Waste TCLP	Hexachlorobenzene	mg/l	5	20%	1	0.02	0.02	0.02	0.02
H	Waste TCLP	Cresol o,m,p (TCLP)	mg/l	5	40%	5	0.01	0.13	0.54	0.54
H	Waste TCLP	Pentachlorophenol	mg/l	5	40%	5	0.05	0.17	0.45	0.45
H	Waste TCLP	2,4,6-Trichlorophenol	mg/l	5	20%	5	0.03	0.03	0.05	0.04
H	Waste TCLP	2-Methylphenol (o-cresol)	mg/l	5	40%	5	0.01	0.03	0.08	0.04
H	Waste TCLP	2,4,5-Trichlorophenol	mg/l	5	20%	1	0.02	0.02	0.02	0.02
H	Waste TCLP	Chlorobenzene	mg/l	5	40%	5	0.01	0.85	2.70	2.01
H	Waste TCLP	Tetrachloroethene	mg/l	5	40%	4	0.01	0.02	0.03	0.03
H	Waste TCLP	Benzene	mg/l	5	40%	5	0.01	0.52	2.50	2.50
H	Waste TCLP	Trichloroethene	mg/l	5	40%	2	0.00	0.00	0.01	0.01

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.



**Table 4-8**  
**Fill Area Composite Sample Summary - Site I**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			
							Minimum	Mean	Maximum	Site Concentration
I	Waste TCLP	1998 Total TEQ w/ EMPC as ND	ug/L	4	100%	4	0.00	0.00	0.00	0.00
I	Waste TCLP	2,4-D	mg/l	4	25%	4	0.01	0.04	0.14	0.14
I	Waste TCLP	Lead	mg/l	4	75%	4	0.10	2.61	8.80	8.80
I	Waste TCLP	Barium	mg/l	4	25%	4	0.50	15.00	58.50	58.50
I	Waste TCLP	Cadmium	mg/l	4	50%	4	0.05	0.28	0.79	0.79
I	Waste TCLP	Cyanide, Total	mg/kg dw	4	50%	4	0.28	0.49	0.73	0.73
I	Waste TCLP	pH	su	4	100%	4	8.20	9.25	10.80	10.80
I	Waste TCLP	Corrosivity-pH	units	4	100%	4	7.41	9.03	11.05	11.05
I	Waste TCLP	Total PCBs	ug/kg dw	4	100%	4	4810.00	520597.50	2050000.00	2050000.00
I	Waste TCLP	1,4-Dichlorobenzene	mg/l	4	75%	4	0.01	0.60	1.30	1.30
I	Waste TCLP	Cresol m & p (TCLP)	mg/l	4	50%	4	0.03	0.06	0.14	0.14
I	Waste TCLP	Pyridine (TCLP)	mg/l	4	25%	1	0.01	0.01	0.01	0.01
I	Waste TCLP	2,4-Dinitrotoluene	mg/l	4	25%	4	0.03	0.03	0.04	0.04
I	Waste TCLP	Cresol o,m,p (TCLP)	mg/l	4	50%	4	0.03	0.08	0.18	0.18
I	Waste TCLP	Pentachlorophenol	mg/l	4	75%	4	0.04	1.29	3.80	3.80
I	Waste TCLP	2,4,6-Trichlorophenol	mg/l	4	25%	1	0.01	0.01	0.01	0.01
I	Waste TCLP	2-Methylphenol (o-cresol)	mg/l	4	25%	1	0.01	0.01	0.01	0.01
I	Waste TCLP	2,4,5-Trichlorophenol	mg/l	4	25%	4	0.03	0.37	1.40	1.40
I	Waste TCLP	Nitrobenzene	mg/l	4	25%	1	0.01	0.01	0.01	0.01
I	Waste TCLP	Chlorobenzene	mg/l	4	75%	4	0.01	2.62	8.90	8.90
I	Waste TCLP	Tetrachloroethene	mg/l	4	25%	4	0.01	0.08	0.29	0.29
I	Waste TCLP	Chloroform	mg/l	4	25%	4	0.01	0.73	2.90	2.90
I	Waste TCLP	Benzene	mg/l	4	75%	4	0.01	0.18	0.51	0.51
I	Waste TCLP	Trichloroethene	mg/l	4	75%	3	0.00	0.00	0.01	0.01

NOTE: Site concentrations in the lower of the given TCLP or the given PCLP.

**Table 4-9**  
**Fill Area Composite Sample Summary - Site L**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
L	Waste TCLP	1998 Total TEQ w/ EMPC as ND	ug/kg	4	100%	4	0.00	0.00	0.00	0.00
L	Waste TCLP	Arsenic	mg/l	4	25%	4	0.10	0.27	0.79	0.79
L	Waste TCLP	Cadmium	mg/l	4	75%	4	0.05	0.18	0.27	0.27
L	Waste TCLP	Total Releasable Sulfide	mg H2S/kg	4	50%	4	25.00	212.50	480.00	478.60
L	Waste TCLP	pH (7.1.4.2) *	su	4	100%	4	8.50	8.80	9.60	9.60
L	Waste TCLP	Corrosivity-pH	units	4	100%	4	7.48	8.09	9.85	9.85
L	Waste TCLP	Total PCBs	ug/kg dw	4	75%	4	95.00	36561.25	80200.00	80200.00
L	Waste TCLP	1,4-Dichlorobenzene	mg/l	4	50%	4	0.03	0.25	0.87	0.87
L	Waste TCLP	Cresol m & p (TCLP)	mg/l	4	25%	4	0.03	0.07	0.19	0.19
L	Waste TCLP	Pyridine (TCLP)	mg/l	4	50%	4	0.04	0.17	0.39	0.39
L	Waste TCLP	Cresol o,m,p (TCLP)	mg/l	4	25%	4	0.03	0.07	0.19	0.19
L	Waste TCLP	Chlorobenzene	mg/l	6	33%	6	0.01	0.01	0.03	0.03
L	Waste TCLP	Tetrachloroethene	mg/l	6	100%	6	0.02	0.03	0.07	0.07
L	Waste TCLP	Trichloroethene	mg/l	6	100%	6	0.00	0.01	0.01	0.01

**Table 4-10**  
**Fill Area Composite Sample Summary - Site N**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics		
							Minimum	Mean	Maximum
N	Waste TCLP	Lead	mg/l	4	75%	3	0.02	0.03	0.05
N	Waste TCLP	Barium	mg/l	4	100%	4	0.68	1.05	1.80
N	Waste TCLP	pH	su	4	100%	4	7.20	8.85	10.40
N	Waste TCLP	Corrosivity-pH	units	4	100%	4	7.32	8.23	9.80
N	Waste TCLP	Benzene	mg/l	4	25%	4	0.01	0.01	0.01
N	Waste TCLP	Trichloroethene	mg/l	4	25%	1	0.00	0.00	0.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

Table 4-11 (1 of 3)  
Ground-Water Sampling Summary - Site I

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
I	Ground Water	1998 Total TEQ w/ EMPC as ND	ug/l	19	100%	19	0.00	0.00	0.01	0.01
I	Ground Water	Dicamba	ug/l	38	3%	1	0.14	0.14	0.14	0.14
I	Ground Water	MCPP[2-(4-chloro-2-methylphenoxy)-propan	ug/l	38	8%	38	60.00	632.28	1800.00	291.91
I	Ground Water	Dinoseb	ug/l	37	3%	1	0.27	0.27	0.27	0.27
I	Ground Water	2,4,5-TP (Silvex)	ug/l	38	18%	38	0.08	0.27	1.10	0.30
I	Ground Water	2,4,5-T	ug/l	38	8%	38	0.25	1.22	16.00	1.04
I	Ground Water	2,4-D	ug/l	38	18%	38	0.14	1.47	18.00	1.35
I	Ground Water	Cyanide, Total	mg/l	38	8%	38	0.01	0.01	0.05	0.01
I	Ground Water	Aluminum	mg/l	38	71%	38	0.02	2.28	13.00	13.00
I	Ground Water	Iron	mg/l	38	95%	38	0.17	36.49	180.00	132.17
I	Ground Water	Lead	mg/l	38	37%	38	0.00	0.11	3.86	0.04
I	Ground Water	Magnesium	mg/l	38	100%	38	29.00	57.12	210.00	62.88
I	Ground Water	Manganese	mg/l	38	100%	38	0.00	1.82	7.70	4.82
I	Ground Water	Mercury	mg/l	38	11%	38	0.00	0.00	0.00	0.00
I	Ground Water	Molybdenum	mg/l	38	68%	38	0.00	0.01	0.04	0.01
I	Ground Water	Nickel	mg/l	38	68%	38	0.00	1.06	27.00	1.67
I	Ground Water	Potassium	mg/l	38	100%	38	6.15	15.84	170.00	16.18
I	Ground Water	Silver	mg/l	38	3%	38	0.01	0.01	0.02	0.01
I	Ground Water	Sodium	mg/l	38	100%	38	20.00	77.96	600.00	83.45
I	Ground Water	Antimony	mg/l	38	3%	37	0.01	0.01	0.06	0.01
I	Ground Water	Arsenic	mg/l	38	53%	38	0.00	0.01	0.14	0.02
I	Ground Water	Barium	mg/l	38	100%	38	0.05	0.50	1.20	0.73
I	Ground Water	Beryllium	mg/l	38	5%	17	0.00	0.00	0.00	0.00
I	Ground Water	Cadmium	mg/l	38	16%	38	0.00	0.00	0.07	0.00
I	Ground Water	Chromium	mg/l	38	55%	38	0.00	0.03	0.20	0.05
I	Ground Water	Cobalt	mg/l	38	53%	38	0.00	0.01	0.05	0.01
I	Ground Water	Copper	mg/l	38	37%	38	0.00	0.10	3.25	0.10
I	Ground Water	Vanadium	mg/l	38	58%	38	0.00	0.01	0.05	0.01
I	Ground Water	Zinc	mg/l	38	50%	38	0.00	1.32	33.00	5.11
I	Ground Water	Calcium	mg/l	38	100%	38	32.00	212.55	520.00	246.30
I	Ground Water	Total PCBs	ug/l	38	34%	38	0.06	414.76	15750.00	5.80
I	Ground Water	Heptachlor epoxide	ug/l	38	26%	37	0.00	0.20	5.60	0.13
I	Ground Water	Aldrin	ug/l	38	8%	3	0.00	0.00	0.01	0.01
I	Ground Water	alpha-BHC	ug/l	38	32%	38	0.01	90.82	3300.00	23.72
I	Ground Water	beta-BHC	ug/l	38	18%	38	0.01	1.82	46.00	2.21
I	Ground Water	delta-BHC	ug/l	38	47%	38	0.00	1.24	41.00	0.50

**Table 1 (2 of 3)**  
**Ground-Water Sampling Summary - Site 1**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Ground Water	Ground Water	Endosulfan II	ug/l	38	11%	37	0.00	0.14	2.00	0.17
Ground Water	Ground Water	4,4'-DDT	ug/l	38	11%	33	0.00	0.05	0.11	0.05
Ground Water	Ground Water	Alpha Chlordane	ug/l	38	3%	1	0.01	0.01	0.01	0.01
Ground Water	Ground Water	Gamma Chlordane	ug/l	38	8%	37	0.01	0.14	3.50	0.09
Ground Water	Ground Water	Endrin ketone	ug/l	38	11%	37	0.00	0.12	1.80	0.14
Ground Water	Ground Water	gamma-BHC (lindane)	ug/l	38	24%	37	0.00	0.03	0.40	0.04
Ground Water	Ground Water	Dieldrin	ug/l	38	8%	3	0.00	0.01	0.01	0.01
Ground Water	Ground Water	Endrin	ug/l	38	3%	1	0.00	0.00	0.00	0.00
Ground Water	Ground Water	Methoxychlor	ug/l	38	5%	37	0.22	0.44	2.80	0.46
Ground Water	Ground Water	4,4'-DDD	ug/l	38	16%	38	0.00	4.84	180.00	0.59
Ground Water	Ground Water	4,4'-DDE	ug/l	38	8%	37	0.00	0.13	2.20	0.14
Ground Water	Ground Water	Heptachlor	ug/l	38	34%	37	0.00	0.11	2.50	0.09
Ground Water	Ground Water	3-Methylphenol/4-Methylphenol	ug/l	38	8%	35	1.70	10.69	110.00	10.06
Ground Water	Ground Water	1,4-Dichlorobenzene	ug/l	38	34%	38	3.00	4111.05	51000.00	51000.00
Ground Water	Ground Water	4-Chloroaniline	ug/l	38	53%	38	3.00	461.16	4100.00	2352.86
Ground Water	Ground Water	Phenol	ug/l	38	18%	36	2.00	13.14	180.00	12.17
Ground Water	Ground Water	bis(2-Chloroethyl)ether	ug/l	38	5%	34	1.10	4.95	7.35	5.18
Ground Water	Ground Water	bis(2-Ethylhexyl)phthalate	ug/l	38	29%	38	0.51	14.67	420.00	7.60
Ground Water	Ground Water	Di-n-octylphthalate	ug/l	38	8%	36	0.50	12.41	180.00	11.47
Ground Water	Ground Water	Hexachlorobenzene	ug/l	38	3%	38	5.00	2387.38	90000.00	127.07
Ground Water	Ground Water	Anthracene	ug/l	38	3%	36	5.00	11.18	130.00	18.52
Ground Water	Ground Water	1,2,4-Trichlorobenzene	ug/l	38	13%	38	0.55	29063.85	1100000.00	1851.59
Ground Water	Ground Water	2,4-Dichlorophenol	ug/l	38	42%	38	1.60	82.23	2400.00	48.68
Ground Water	Ground Water	N-Nitrosodiphenylamine/Diphenylamine	ug/l	38	32%	38	0.47	32.14	760.00	30.19
Ground Water	Ground Water	Pyrene	ug/l	38	3%	38	5.00	33.22	540.00	26.06
Ground Water	Ground Water	Dibenzofuran	ug/l	38	3%	35	5.00	5.40	19.00	5.70
Ground Water	Ground Water	Benzo(g,h,i)perylene	ug/l	38	13%	38	2.50	26.72	300.00	23.24
Ground Water	Ground Water	Indeno(1,2,3-cd)pyrene	ug/l	38	11%	37	0.86	19.03	240.00	16.45
Ground Water	Ground Water	Benzo(b)fluoranthene	ug/l	38	13%	38	0.30	26.30	280.00	29.14
Ground Water	Ground Water	Fluoranthene	ug/l	38	8%	37	0.41	12.43	170.00	12.26
Ground Water	Ground Water	Benzo(k)fluoranthene	ug/l	38	13%	37	0.74	18.41	220.00	16.72
Ground Water	Ground Water	Chrysene	ug/l	38	11%	38	0.73	38.26	740.00	29.99
Ground Water	Ground Water	Benzo(e)pyrene	ug/l	38	21%	38	0.45	28.35	380.00	31.69
Ground Water	Ground Water	Dibenzo(a,h)anthracene	ug/l	38	18%	37	0.85	17.97	210.00	16.57

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Ta' 4-11 (3 of 3)  
Ground-Water Sampling Summary - Site I

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			
							Minimum	Mean	Maximum	Site Concentration
I	Ground Water	1,3-Dichlorobenzene	ug/l	38	74%	38,0000	0.42	100.85	1100.00	436.23
I	Ground Water	Benzol(a)anthracene	ug/l	38	13%	38,0000	0.38	29.17	400.00	29.88
I	Ground Water	4-Chloro-3-methylphenol	ug/l	38	3%	1,0000	1.50	1.50	1.50	1.50
I	Ground Water	Acenaphthene	ug/l	38	8%	38,0000	2.10	11.04	130.00	10.05
I	Ground Water	Diethylphthalate	ug/l	38	5%	34,0000	3.25	4.85	5.10	5.04
I	Ground Water	Di-n-butylphthalate	ug/l	38	18%	38,0000	0.29	26.20	300.00	39.40
I	Ground Water	Phenanthrene	ug/l	38	13%	38,0000	0.47	35.28	780.00	28.58
I	Ground Water	Butylbenzylphthalate	ug/l	38	8%	38,0000	2.77	12.09	180.00	10.69
I	Ground Water	Fluorene	ug/l	38	8%	38,0000	0.50	11.51	360.00	4.75
I	Ground Water	Carbazole	ug/l	38	21%	38,0000	1.40	15.21	240.00	17.11
I	Ground Water	Pentachlorophenol	ug/l	38	16%	38,0000	1.28	29.43	575.00	20.17
I	Ground Water	2,4,6-Trichlorophenol	ug/l	38	5%	38,0000	1.05	49.03	1700.00	12.86
I	Ground Water	Naphthalene	ug/l	38	63%	38,0000	0.57	213.10	5900.00	181.48
I	Ground Water	2-Methylnaphthalene	ug/l	38	11%	38,0000	4.20	38.59	670.00	27.21
I	Ground Water	2-Methylphenol (o-cresol)	ug/l	38	8%	34,0000	0.39	5.28	21.00	6.47
I	Ground Water	1,2-Dichlorobenzene	ug/l	38	68%	38,0000	1.10	387.83	12000.00	494.59
I	Ground Water	2-Chlorophenol	ug/l	38	61%	34,0000	3.00	18.58	84.00	23.74
I	Ground Water	2,4,5-Trichlorophenol	ug/l	38	5%	35,0000	1.80	7.84	100.90	7.37
I	Ground Water	Nitrobenzene	ug/l	38	3%	38,0000	1.75	10.40	140.00	8.63
I	Ground Water	Ethylbenzene	ug/l	38	42%	38,0000	2.50	114.87	870.00	478.62
I	Ground Water	Toluene	ug/l	38	29%	32,0000	0.72	23.68	86.00	74.67
I	Ground Water	Chlorobenzene	ug/l	38	55%	38,0000	0.68	5300.65	34000.00	34000.00
I	Ground Water	Tetrachloroethene	ug/l	38	21%	31,0000	0.86	24.61	83.00	62.26
I	Ground Water	Xylenes, Total	ug/l	38	16%	23,0000	2.50	13.26	36.00	16.91
I	Ground Water	Cis/Trans-1,2-Dichloroethene	ug/l	38	32%	38,0000	1.75	170.65	1400.00	967.86
I	Ground Water	Benzene	ug/l	38	79%	38,0000	0.60	128.73	750.00	750.00
I	Ground Water	Vinyl chloride	ug/l	38	28%	37,0000	1.20	154.59	970.00	738.39
I	Ground Water	1,1-Dichloroethane	ug/l	38	29%	38,0000	2.50	105.38	960.00	427.73
I	Ground Water	1,1-Dichloroethene	ug/l	38	16%	37,0000	2.10	66.38	330.00	211.72
I	Ground Water	Trichloroethene	ug/l	38	16%	37,0000	0.66	36.41	180.00	135.46

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-12 (1 of 3)  
Ground-Water Sample Summary - Sites G, H, and L

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
GHL	Ground Water	1998 Total TEQ w/ EMPC as ND	ug/l	28	100%	28	0.00	0.00	0.01	0.00
GHL	Ground Water	Dichloroprop	ug/l	50	4%	48	3.00	4.98	47.00	5.21
GHL	Ground Water	MCPP[2-(4-chloro-2-methylphenoxy)-propan	ug/l	50	10%	47	60.00	420.00	4250.00	401.53
GHL	Ground Water	Dinoseb	ug/l	50	2%	1	0.32	0.32	0.32	0.32
GHL	Ground Water	2,4,5-TP (Silvex)	ug/l	50	8%	50	0.05	12.34	390.00	4.94
GHL	Ground Water	2,4,5-T	ug/l	50	8%	49	0.25	2.68	35.00	2.23
GHL	Ground Water	MCPA[(4-chloro-2-methylphenoxy)-acetic a	ug/l	50	2%	45	60.00	82.00	720.00	97.29
GHL	Ground Water	2,4-D	ug/l	50	12%	50	0.25	17.48	380.00	13.44
GHL	Ground Water	Cyanide, Total	mg/l	50	2%	50	0.01	0.01	0.02	0.01
GHL	Ground Water	Aluminum	mg/l	50	84%	50	0.02	2.51	33.00	5.38
GHL	Ground Water	Iron	mg/l	50	100%	50	0.20	35.17	290.00	107.76
GHL	Ground Water	Lead	mg/l	50	34%	49	0.00	0.01	0.05	0.01
GHL	Ground Water	Magnesium	mg/l	50	100%	50	18.00	48.44	160.00	61.78
GHL	Ground Water	Manganese	mg/l	50	100%	50	0.04	1.72	10.00	2.61
GHL	Ground Water	Mercury	mg/l	50	4%	50	0.00	0.00	0.00	0.00
GHL	Ground Water	Molybdenum	mg/l	50	72%	50	0.00	0.02	0.45	0.02
GHL	Ground Water	Nickel	mg/l	50	76%	50	0.01	3.87	180.00	0.70
GHL	Ground Water	Potassium	mg/l	50	100%	50	3.00	9.74	29.00	11.20
GHL	Ground Water	Sodium	mg/l	50	100%	50	7.30	37.39	230.00	45.18
GHL	Ground Water	Thallium	mg/l	50	4%	50	0.00	0.00	0.01	0.01
GHL	Ground Water	Antimony	mg/l	50	16%	50	0.01	0.01	0.15	0.01
GHL	Ground Water	Arsenic	mg/l	50	58%	50	0.00	0.16	4.30	0.15
GHL	Ground Water	Barium	mg/l	50	100%	50	0.02	0.28	0.98	0.38
GHL	Ground Water	Beryllium	mg/l	50	8%	22	0.00	0.00	0.00	0.00
GHL	Ground Water	Cadmium	mg/l	50	8%	49	0.00	0.00	0.00	0.00
GHL	Ground Water	Chromium	mg/l	50	50%	50	0.00	0.04	0.57	0.05
GHL	Ground Water	Cobalt	mg/l	50	60%	50	0.00	0.02	0.22	0.02
GHL	Ground Water	Copper	mg/l	50	30%	50	0.00	0.01	0.10	0.03
GHL	Ground Water	Vanadium	mg/l	50	36%	50	0.00	0.02	0.33	0.01
GHL	Ground Water	Zinc	mg/l	50	36%	50	0.00	0.13	1.30	0.22
GHL	Ground Water	Calcium	mg/l	50	100%	50	84.00	213.48	720.00	238.68
GHL	Ground Water	Selenium	mg/l	50	4%	50	0.01	0.01	0.01	0.01
GHL	Ground Water	Total PCBs	ug/l	50	28%	50	0.08	2.02	54.50	1.44
GHL	Ground Water	Heptachlor epoxide	ug/l	50	12%	49	0.01	0.19	4.40	0.10
GHL	Ground Water	Aldrin	ug/l	50	8%	46	0.03	0.03	0.07	0.03
GHL	Ground Water	alpha-BHC	ug/l	50	12%	50	0.01	26.28	1285.00	0.93

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-1a (-- of 3)**  
**Ground-Water Sample Summary - Sites G, H, and L**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
GHL	Ground Water	beta-BHC	ug/l	50	8%	50	0.01	1.82	85.70	0.32
GHL	Ground Water	delta-BHC	ug/l	50	40%	50	0.00	0.43	17.00	0.21
GHL	Ground Water	4,4'-DDT	ug/l	50	10%	50	0.03	0.64	14.00	0.44
GHL	Ground Water	Alpha Chlordane	ug/l	50	8%	48	0.02	0.10	2.40	0.06
GHL	Ground Water	Gamma Chlordane	ug/l	50	12%	46	0.01	0.03	0.14	0.03
GHL	Ground Water	Erdin ketone	ug/l	50	2%	1	0.01	0.01	0.01	0.01
GHL	Ground Water	gamma-BHC (lindane)	ug/l	50	34%	44	0.00	0.01	0.07	0.02
GHL	Ground Water	Diethn	ug/l	50	10%	50	0.00	0.40	8.00	0.27
GHL	Ground Water	Endin	ug/l	50	8%	47	0.01	0.06	0.36	0.06
GHL	Ground Water	Methoxydior	ug/l	50	4%	47	0.07	0.40	6.43	0.37
GHL	Ground Water	4,4'-DDD	ug/l	50	14%	46	0.02	0.08	0.90	0.08
GHL	Ground Water	4,4'-DDE	ug/l	50	14%	46	0.00	0.05	0.16	0.06
GHL	Ground Water	Erdin aldehyde	ug/l	50	8%	46	0.00	0.06	0.74	0.07
GHL	Ground Water	Heptachlor	ug/l	50	24%	46	0.00	0.02	0.04	0.02
GHL	Ground Water	Endosulfan I	ug/l	50	6%	46	0.00	0.02	0.04	0.03
GHL	Ground Water	4-Nitroaniline	ug/l	50	2%	1	8.40	8.40	8.40	8.40
GHL	Ground Water	4-Bromophenylphenyl ether	ug/l	50	2%	47	0.50	0.56	3.20	0.65
GHL	Ground Water	3-Methylphenol/4-Methylphenol (m/p-Cresol)	ug/l	50	14%	50	0.76	66.51	2400.00	29.63
GHL	Ground Water	1,4-Dichlorobenzene	ug/l	50	38%	50	0.92	517.29	14000.00	1088.79
GHL	Ground Water	4-Chloroaniline	ug/l	50	18%	50	1.00	566.67	23000.00	195.27
GHL	Ground Water	Phend	ug/l	50	8%	50	5.00	306.17	14000.00	52.58
GHL	Ground Water	bis[2-Ethylhexyl]phthalate	ug/l	50	18%	48	0.80	1.90	32.00	1.73
GHL	Ground Water	Dih-n-octylphthalate	ug/l	50	2%	1	0.39	0.39	0.39	0.39
GHL	Ground Water	Hexachlorobenzene	ug/l	50	10%	50	0.35	102.96	4460.00	27.02
GHL	Ground Water	Anthracene	ug/l	50	4%	2	0.39	2.56	4.73	4.73
GHL	Ground Water	1,2,4-Trichlorobenzene	ug/l	50	22%	50	1.30	1080.00	48200.00	363.82
GHL	Ground Water	2,4-Dichlorophenol	ug/l	50	26%	50	0.75	89.78	3600.00	33.38
GHL	Ground Water	N-Nitrosodiphenylamine/Diphenylamine	ug/l	50	4%	48	2.50	2.86	14.85	3.00
GHL	Ground Water	Pyrene	ug/l	50	2%	48	5.00	5.71	39.05	5.89
GHL	Ground Water	Dimethylphthalate	ug/l	50	2%	1	3.65	3.65	3.65	3.65
GHL	Ground Water	Dibenzoduran	ug/l	50	4%	2	0.31	0.71	1.10	1.10
GHL	Ground Water	Benzof(g,h,i)pyrene	ug/l	50	6%	47	0.90	4.87	5.90	5.05
GHL	Ground Water	Indeno(1,2,3-cd)pyrene	ug/l	50	4%	47	1.80	4.94	5.60	5.06
GHL	Ground Water	Benzof(b)fluoranthene	ug/l	50	4%	2	0.52	2.11	3.70	3.70
GHL	Ground Water	Fluoranthene	ug/l	50	4%	48	0.52	4.94	6.60	5.11
GHL	Ground Water	Benzof(k)fluoranthene	ug/l	50	4%	48	5.00	5.99	51.40	6.06

NOTE: Site concentration is the lower of the 85% UCL or the maximum detected concentration.



Table 4-12 (3 of 3)  
Ground-Water Sample Summary - Sites G, H, and L

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
GHL	Ground Water	Chrysene	ug/l	50	4%	48	2.40	6.15	62.70	6.18
GHL	Ground Water	Benzo(a)pyrene	ug/l	50	4%	47	0.50	4.92	5.70	5.08
GHL	Ground Water	Dibenzo(a,h)anthracene	ug/l	50	4%	48	4.80	5.96	51.50	6.06
GHL	Ground Water	4,6-Dinitro-2-methylphenol	ug/l	50	2%	47	6.50	6.66	14.00	8.93
GHL	Ground Water	1,3-Dichlorobenzene	ug/l	50	24%	49	0.36	12.02	140.00	12.18
GHL	Ground Water	Benzo(a)anthracene	ug/l	50	2%	1	1.90	1.90	1.90	1.90
GHL	Ground Water	4-Chloro-3-methylphenol	ug/l	50	2%	1	1.00	1.00	1.00	1.00
GHL	Ground Water	Hexachlorocyclopentadiene	ug/l	50	2%	48	5.00	5.94	50.00	6.04
GHL	Ground Water	Isophorone	ug/l	50	4%	48	0.75	5.85	50.22	6.23
GHL	Ground Water	Acenaphthene	ug/l	50	2%	1	2.20	2.20	2.20	2.20
GHL	Ground Water	Diethylphthalate	ug/l	50	6%	47	2.10	5.32	21.00	5.62
GHL	Ground Water	Di-n-butylphthalate	ug/l	50	20%	10	0.26	0.87	2.76	1.86
GHL	Ground Water	Phenanthrene	ug/l	50	8%	48	0.89	5.53	37.26	6.03
GHL	Ground Water	Butylbenzylphthalate	ug/l	50	2%	48	5.00	5.96	50.60	6.03
GHL	Ground Water	Fluorene	ug/l	50	16%	50	0.50	2.32	30.00	1.98
GHL	Ground Water	Carbazole	ug/l	50	10%	48	1.15	4.12	17.50	4.88
GHL	Ground Water	Pentachlorophenol	ug/l	50	38%	50	1.28	115.12	3350.00	88.88
GHL	Ground Water	2,4,6-Trichlorophenol	ug/l	50	12%	50	0.47	18.87	485.00	9.98
GHL	Ground Water	2-Nitroaniline	ug/l	50	2%	1	13.50	13.50	13.50	13.50
GHL	Ground Water	Naphthalene	ug/l	50	16%	50	3.20	111.02	2300.00	58.07
GHL	Ground Water	2-Methylnaphthalene	ug/l	50	6%	48	3.40	5.18	12.00	5.36
GHL	Ground Water	2-Chloronaphthalene	ug/l	50	2%	47	5.00	5.15	12.00	5.30
GHL	Ground Water	2-Methylphenol (o-cresol)	ug/l	50	10%	49	5.00	11.98	230.00	10.36
GHL	Ground Water	1,2-Dichlorobenzene	ug/l	50	46%	50	0.78	55.98	720.00	88.87
GHL	Ground Water	2-Chlorophenol	ug/l	50	32%	50	0.44	24.83	630.00	18.56
GHL	Ground Water	2,4,5-Trichlorophenol	ug/l	50	16%	48	1.00	13.11	190.00	11.47
GHL	Ground Water	Nitrobenzene	ug/l	50	2%	48	1.75	3.24	58.50	2.81
GHL	Ground Water	Ethylbenzene	ug/l	50	20%	50	0.98	43.81	1800.00	12.57

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-13 (1 of 2)  
Ground-Water Sampling Summary - Residential Areas

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
RES AREA	Ground Water	1998 Total TEQ w/ EMPC as ND	ug/l	15	100%	15	0.00	0.00	0.00	0.00
RES AREA	Ground Water	2,4,5-TP (Sivex)	ug/l	15	13%	2	0.10	0.10	0.11	0.11
RES AREA	Ground Water	2,4-DB	ug/l	14	7%	14	0.25	0.28	0.68	0.33
RES AREA	Ground Water	Aluminum	mg/l	15	53%	15	0.03	2.52	17.00	17.00
RES AREA	Ground Water	Iron	mg/l	15	100%	15	1.90	10.49	42.00	15.71
RES AREA	Ground Water	Lead	mg/l	15	67%	15	0.00	0.01	0.08	0.03
RES AREA	Ground Water	Magnesium	mg/l	15	100%	15	8.80	28.25	39.00	32.12
RES AREA	Ground Water	Manganese	mg/l	15	100%	15	0.35	1.28	1.70	1.44
RES AREA	Ground Water	Mercury	mg/l	15	33%	15	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Molybdenum	mg/l	15	27%	15	0.00	0.01	0.01	0.01
RES AREA	Ground Water	Nickel	mg/l	15	67%	15	0.00	0.02	0.08	0.04
RES AREA	Ground Water	Potassium	mg/l	15	100%	15	4.00	8.80	18.00	8.02
RES AREA	Ground Water	Sodium	mg/l	15	100%	15	9.50	19.50	29.00	21.86
RES AREA	Ground Water	Arsenic	mg/l	15	80%	15	0.00	0.01	0.04	0.02
RES AREA	Ground Water	Barium	mg/l	15	100%	15	0.13	0.31	0.55	0.39
RES AREA	Ground Water	Beryllium	mg/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Cadmium	mg/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Chromium	mg/l	15	53%	15	0.00	0.01	0.08	0.02
RES AREA	Ground Water	Cobalt	mg/l	15	73%	15	0.00	0.01	0.02	0.01
RES AREA	Ground Water	Copper	mg/l	15	60%	15	0.00	0.01	0.08	0.02
RES AREA	Ground Water	Vanadium	mg/l	15	53%	15	0.00	0.01	0.08	0.02
RES AREA	Ground Water	Zinc	mg/l	15	80%	15	0.01	0.25	2.30	1.09
RES AREA	Ground Water	Calcium	mg/l	15	100%	15	80.00	143.33	180.00	155.20
RES AREA	Ground Water	Total PCBs	ug/l	15	7%	1	0.06	0.06	0.06	0.06
RES AREA	Ground Water	Heptachlor epoxide	ug/l	15	13%	2	0.00	0.00	0.00	0.00
RES AREA	Ground Water	alpha-BHC	ug/l	15	13%	2	0.00	0.00	0.00	0.00
RES AREA	Ground Water	beta-BHC	ug/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	delta-BHC	ug/l	15	13%	3	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Alpha Chlordane	ug/l	15	0%	0	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Gamma Chlordane	ug/l	15	13%	2	0.00	0.00	0.00	0.00
RES AREA	Ground Water	gamma-BHC (Lindane)	ug/l	15	20%	15	0.00	0.01	0.03	0.01
RES AREA	Ground Water	Dieldrin	ug/l	15	13%	2	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Methoxychlor	ug/l	15	7%	1	0.01	0.01	0.01	0.01
RES AREA	Ground Water	4,4'-DDD	ug/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	4,4'-DDE	ug/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Endrin aldehyde	ug/l	15	7%	1	0.00	0.00	0.00	0.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table .3 (2 of 2)  
Ground-Water Sampling Summary - Residential Areas

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
RES AREA	Ground Water	Heptachlor	ug/l	15	7%	1	0.00	0.00	0.00	0.00
RES AREA	Ground Water	Endosulfan I	ug/l	15	0%	0	0.00	0.00	0.00	0.00
RES AREA	Ground Water	1,4-Dichlorobenzene	ug/l	15	13%	2	0.32	0.36	0.39	0.39
RES AREA	Ground Water	bat(2-Ethylhexyl)phthalate	ug/l	15	7%	1	0.70	0.70	0.70	0.70
RES AREA	Ground Water	Benzo(g,h,i)pyrene	ug/l	15	13%	2	0.72	0.91	1.10	1.10
RES AREA	Ground Water	Indeno(1,2,3-cd)pyrene	ug/l	15	7%	1	0.66	0.66	0.66	0.66
RES AREA	Ground Water	Benzo(b)fluoranthene	ug/l	15	7%	1	0.44	0.44	0.44	0.44
RES AREA	Ground Water	Fluoranthene	ug/l	15	13%	2	0.36	0.40	0.44	0.44
RES AREA	Ground Water	Acenaphthylene	ug/l	15	13%	2	0.65	0.76	0.87	0.87
RES AREA	Ground Water	Chrysene	ug/l	15	13%	2	0.45	0.58	0.70	0.70
RES AREA	Ground Water	Benzo(a)pyrene	ug/l	15	7%	1.00	0.49	0.49	0.49	0.49
RES AREA	Ground Water	Benzo(a)anthracene	ug/l	15	13%	2.00	0.37	0.45	0.52	0.52
RES AREA	Ground Water	Dih-n-butylphthalate	ug/l	15	7%	1.00	0.37	0.37	0.37	0.37
RES AREA	Ground Water	Phenanthrene	ug/l	15	7%	1.00	0.38	0.38	0.38	0.38
RES AREA	Ground Water	Fluorene	ug/l	15	13%	15.00	0.50	0.63	1.60	0.78
RES AREA	Ground Water	Pentachlorophenol	ug/l	15	7%	1.00	1.29	1.29	1.29	1.29
RES AREA	Ground Water	Toluene	ug/l	15	7%	1.00	0.59	0.59	0.59	0.59
RES AREA	Ground Water	Carbon disulfide	ug/l	15	0%	15.00	2.50	2.50	2.50	2.50
RES AREA	Ground Water	Trichloroethene	ug/l	15	7%	1.00	0.64	0.64	0.64	0.64

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4 - 14**  
**Hydraulic Conductivity Estimates Based on RI/FS Slug Test Data**  
**Sauget Area 1**

<u>Horizon</u>	<u>Areas</u>			
	<u>G</u>	<u>H</u>	<u>I</u>	<u>N</u>
Shallow	6.240E-03	4.320E-03	4.530E-03	2.710E-02
Middle	3.470E-02	2.140E-02	5.070E-02	2.200E-02
Deep	3.310E-02	1.840E-02	1.270E-01	1.370E-02

Notes: Units are in centimeters per second (cm/sec)

Table 4-1b (1 of 3)  
Floodplain Soils - Surface Sample Summary

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Surface Soil	1998 Total TEO w/ EMPC as ND	ug/kg dw	29	100%	29	0.00	0.01	0.05	0.01
Combined	Surface Soil	Dicamba	ug/kg dw	65	23%	18	1.30	3.62	23.00	4.90
Combined	Surface Soil	MCP	ug/kg dw	65	15%	65	1000.00	1735.77	7700.00	1858.56
Combined	Surface Soil	MCPA	ug/kg dw	65	20%	65	1000.00	1682.69	7400.00	1784.21
Combined	Surface Soil	2,4-D	ug/kg dw	65	2%	2	3.80	6.60	9.60	9.60
Combined	Surface Soil	2,4-DB	ug/kg dw	65	6%	65	4.25	6.40	41.00	6.62
Combined	Surface Soil	Aluminum	mg/kg dw	65	100%	65	3300.00	9390.77	18000.00	10122.05
Combined	Surface Soil	Iron	mg/kg dw	65	100%	65	4100.00	15326.92	25000.00	16347.92
Combined	Surface Soil	Lead	mg/kg dw	65	100%	65	24.00	70.85	260.00	78.92
Combined	Surface Soil	Magnesium	mg/kg dw	65	100%	65	2800.00	5853.08	21000.00	6447.60
Combined	Surface Soil	Manganese	mg/kg dw	65	100%	65	120.00	398.31	1200.00	428.96
Combined	Surface Soil	Mercury	mg/kg dw	65	100%	65	0.03	0.06	0.57	0.06
Combined	Surface Soil	Molybdenum	mg/kg dw	65	96%	65	0.22	0.73	3.20	0.81
Combined	Surface Soil	Nickel	mg/kg dw	65	100%	65	12.00	19.12	55.00	20.02
Combined	Surface Soil	Potassium	mg/kg dw	65	100%	65	1200.00	2016.92	3800.00	2135.21
Combined	Surface Soil	Silver	mg/kg dw	65	49%	65	0.20	0.45	0.60	0.49
Combined	Surface Soil	Thallium	mg/kg dw	65	26%	65	0.49	0.64	1.40	0.68
Combined	Surface Soil	Antimony	mg/kg dw	65	42%	65	0.32	1.15	2.60	1.24
Combined	Surface Soil	Arsenic	mg/kg dw	65	100%	65	2.60	7.41	34.00	7.88
Combined	Surface Soil	Barium	mg/kg dw	65	100%	65	40.00	186.45	1200.00	198.46
Combined	Surface Soil	Beryllium	mg/kg dw	65	85%	65	0.17	0.56	1.10	0.62
Combined	Surface Soil	Cadmium	mg/kg dw	65	100%	65	0.46	2.44	8.40	2.77
Combined	Surface Soil	Chromium	mg/kg dw	65	100%	65	11.00	16.92	49.00	17.93
Combined	Surface Soil	Cobalt	mg/kg dw	65	100%	65	2.30	6.62	11.00	7.01
Combined	Surface Soil	Copper	mg/kg dw	65	100%	65	18.00	69.91	230.00	80.94
Combined	Surface Soil	Vanadium	mg/kg dw	65	100%	65	13.00	28.20	120.00	29.81
Combined	Surface Soil	Zinc	mg/kg dw	65	100%	65	78.00	293.66	1400.00	331.63
Combined	Surface Soil	Calcium	mg/kg dw	65	100%	65	3500.00	26070.00	250000.00	30365.04
Combined	Surface Soil	Selenium	mg/kg dw	65	25%	65	0.48	0.63	3.20	0.66
Combined	Surface Soil	Total PCBs	ug/kg dw	65	82%	65	7.50	63.78	385.00	90.43
Combined	Surface Soil	Heptachlor epoxide	ug/kg dw	65	25%	65	0.09	1.74	30.00	2.04
Combined	Surface Soil	Endosulfan sulfate	ug/kg dw	65	18%	40	0.09	1.42	1.90	1.60
Combined	Surface Soil	Aldrin	ug/kg dw	65	2%	65	0.90	1.72	23.00	1.68
Combined	Surface Soil	alpha-BHC	ug/kg dw	65	2%	1	0.22	0.22	0.22	0.22
Combined	Surface Soil	beta-BHC	ug/kg dw	65	11%	65	0.10	0.50	3.80	0.54
Combined	Surface Soil	delta-BHC	ug/kg dw	65	6%	5	0.08	0.16	0.24	0.22

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-15 (< of 3)**  
**Floodplain Soils - Surface Sample Summary**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Surface Soil	Endosulfan II	ug/kg dw	65	2%	1	1.00	1.00	1.00	1.00
Combined	Surface Soil	4,4'-DDT	ug/kg dw	65	48%	65	0.12	8.81	140.00	7.95
Combined	Surface Soil	Alpha Chlordane	ug/kg dw	65	20%	65	0.16	2.74	54.00	2.55
Combined	Surface Soil	Gamma Chlordane	ug/kg dw	65	22%	65	0.10	4.09	78.00	3.26
Combined	Surface Soil	Endrin ketone	ug/kg dw	65	37%	61	0.12	1.61	4.95	2.56
Combined	Surface Soil	gamma-BHC (Lindane)	ug/kg dw	65	3%	2	0.09	0.11	0.13	0.13
Combined	Surface Soil	Diadrin	ug/kg dw	65	29%	65	0.09	4.25	120.00	3.86
Combined	Surface Soil	Endrin	ug/kg dw	65	6%	60	0.10	1.98	6.10	2.31
Combined	Surface Soil	Methoxychlor	ug/kg dw	65	37%	62	0.10	1.98	6.10	2.31
Combined	Surface Soil	4,4'-DDD	ug/kg dw	65	8%	65	0.93	8.67	38.00	11.61
Combined	Surface Soil	4,4'-DDE	ug/kg dw	65	54%	65	0.56	2.98	36.00	3.01
Combined	Surface Soil	Endrin aldehyde	ug/kg dw	65	5%	60	0.09	3.21	54.00	4.04
Combined	Surface Soil	Hepachlor	ug/kg dw	65	6%	65	0.24	1.97	5.06	2.16
Combined	Surface Soil	bis(2-Ethylhexyl)phthalate	ug/kg dw	65	29%	65	0.34	2.79	91.00	1.98
Combined	Surface Soil	Anthracene	ug/kg dw	65	23%	65	29.00	103.78	430.00	111.40
Combined	Surface Soil	Pyrene	ug/kg dw	65	49%	65	26.00	158.17	2300.00	152.06
Combined	Surface Soil	Dibenzofuran	ug/kg dw	65	8%	65	72.00	533.40	8500.00	443.38
Combined	Surface Soil	Benzo(g,h,i)perylene	ug/kg dw	65	37%	65	45.00	108.79	770.00	112.43
Combined	Surface Soil	Indeno(1,2,3-cd)pyrene	ug/kg dw	65	28%	65	38.00	196.50	2200.00	200.63
Combined	Surface Soil	Benzo(b)fluoranthene	ug/kg dw	65	55%	65	51.00	192.21	2000.00	194.80
Combined	Surface Soil	Fluoranthene	ug/kg dw	65	40%	65	27.00	302.78	4400.00	281.83
Combined	Surface Soil	Benzo(k)fluoranthene	ug/kg dw	65	60%	65	37.00	647.73	10000.00	558.34
Combined	Surface Soil	Acenaphthylene	ug/kg dw	65	6%	4	37.00	271.58	3400.00	249.13
Combined	Surface Soil	Chrysene	ug/kg dw	65	63%	65	24.00	45.50	75.00	75.00
Combined	Surface Soil	Benzo(e)pyrene	ug/kg dw	65	40%	65	28.00	340.05	4900.00	318.52
Combined	Surface Soil	Dibenz(a,h)anthracene	ug/kg dw	65	18%	65	43.00	260.88	3600.00	226.25
Combined	Surface Soil	Benzo(a)anthracene	ug/kg dw	65	57%	65	26.00	89.11	610.00	90.28
Combined	Surface Soil	Acenaphthene	ug/kg dw	65	14%	65	23.00	293.16	4300.00	265.63
Combined	Surface Soil	Diethylphthalate	ug/kg dw	65	2%	1	16.00	118.93	1200.00	123.59
Combined	Surface Soil	Di-n-butylphthalate	ug/kg dw	65	15%	65	39.00	39.00	39.00	39.00
Combined	Surface Soil	Phenanthrene	ug/kg dw	65	52%	65	32.00	94.56	170.00	100.48
Combined	Surface Soil	Butylbenzylphthalate	ug/kg dw	65	5%	65	22.00	461.15	9200.00	365.97
Combined	Surface Soil	Fluorene	ug/kg dw	65	11%	65	57.00	99.73	340.00	103.25
Combined	Surface Soil	Carbazole	ug/kg dw	65	17%	65	44.00	125.64	1400.00	125.66
Combined	Surface Soil	Pentachlorophenol	ug/kg dw	65	55%	65	58.00	125.45	1000.00	127.09
Combined	Surface Soil	Naphthalene	ug/kg dw	65	3%	2	221.10	267.32	740.00	278.19
Combined	Surface Soil	2-Methylnaphthalene	ug/kg dw	65	5%	3	41.00	60.00	79.00	79.00
Combined	Surface Soil		ug/kg dw	65	5%	3	61.50	66.17	72.00	72.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

**Table 4-15 (3 of 3)**  
**Floodplain Soils - Surface Sample Summary**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Surface Soil	Ethylbenzene	ug/kg dw	65	2%	47	2.05	2.73	3.00	2.78
Combined	Surface Soil	Toluene	ug/kg dw	65	20%	65	2.05	3.19	12.00	3.34
Combined	Surface Soil	Chlorobenzene	ug/kg dw	65	2%	64	2.05	2.88	4.00	2.95
Combined	Surface Soil	Xylenes, Total	ug/kg dw	65	2%	65	2.05	2.91	4.20	2.99
Combined	Surface Soil	2-Hexanone	ug/kg dw	65	5%	3	4.80	8.10	8.80	8.90
Combined	Surface Soil	Acetone	ug/kg dw	65	49%	65	20.50	177.33	670.00	282.66
Combined	Surface Soil	Benzene	ug/kg dw	65	8%	65	1.80	2.88	4.80	2.97
Combined	Surface Soil	Methylene chloride (Dichloromethane)	ug/kg dw	65	5%	6	1.80	2.16	2.40	2.38
Combined	Surface Soil	Carbon disulfide	ug/kg dw	65	5%	65	2.05	2.90	4.30	2.98
Combined	Surface Soil	2-Butanone (MEK)	ug/kg dw	65	35%	65	9.10	19.28	47.00	20.85
Combined	Surface Soil	Trichloroethene	ug/kg dw	65	6%	65	2.05	2.87	6.20	3.07

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4 (1 of 3)**  
**Floodplain Soils - Subsurface Sample Summary**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Subsurface Soil	1998 Total TEQ w/ EMPC as ND	ug/kg dw	13	100%	13	0.01	0.05	0.14	0.08
Combined	Subsurface Soil	Dicamba	ug/kg dw	65	2%	1	1.30	1.30	1.30	1.30
Combined	Subsurface Soil	MCP	ug/kg dw	65	5%	65	1000.00	1255.00	3000.00	1304.85
Combined	Subsurface Soil	2,4,5-TP (Silvex)	ug/kg dw	65	2%	1	1.50	1.50	1.50	1.50
Combined	Subsurface Soil	MCPA	ug/kg dw	65	5%	65	1000.00	1203.48	2300.00	1234.06
Combined	Subsurface Soil	2,4-DB	ug/kg dw	65	2%	65	4.25	4.81	7.70	7.70
Combined	Subsurface Soil	Aluminum	mg/kg dw	65	100%	65	2100.00	7065.38	22000.00	7784.44
Combined	Subsurface Soil	Iron	mg/kg dw	65	100%	65	5000.00	12289.23	28000.00	13053.65
Combined	Subsurface Soil	Lead	mg/kg dw	65	100%	65	4.50	21.05	240.00	20.55
Combined	Subsurface Soil	Magnesium	mg/kg dw	65	100%	65	1700.00	5787.89	11000.00	6229.53
Combined	Subsurface Soil	Manganese	mg/kg dw	65	100%	65	92.00	280.57	980.00	304.43
Combined	Subsurface Soil	Mercury	mg/kg dw	65	83%	65	0.00	0.03	0.28	0.04
Combined	Subsurface Soil	Molybdenum	mg/kg dw	65	94%	65	0.16	0.48	1.10	0.51
Combined	Subsurface Soil	Nickel	mg/kg dw	65	100%	65	7.40	15.67	42.00	16.62
Combined	Subsurface Soil	Potassium	mg/kg dw	65	100%	65	490.00	1416.82	4000.00	1548.10
Combined	Subsurface Soil	Sodium	mg/kg dw	65	25%	65	24.00	82.58	380.00	101.37
Combined	Subsurface Soil	Thallium	mg/kg dw	65	3%	65	0.48	0.57	0.72	0.72
Combined	Subsurface Soil	Antimony	mg/kg dw	65	22%	64	0.56	1.06	2.60	1.12
Combined	Subsurface Soil	Arsenic	mg/kg dw	65	100%	65	1.90	5.38	11.00	5.72
Combined	Subsurface Soil	Barium	mg/kg dw	65	100%	65	45.00	179.77	280.00	193.47
Combined	Subsurface Soil	Beryllium	mg/kg dw	65	75%	65	0.12	0.40	1.20	0.43
Combined	Subsurface Soil	Cadmium	mg/kg dw	65	82%	65	0.08	0.51	7.90	0.49
Combined	Subsurface Soil	Chromium	mg/kg dw	65	100%	65	5.80	15.06	130.00	15.89
Combined	Subsurface Soil	Cobalt	mg/kg dw	65	100%	65	2.80	5.69	11.00	5.88
Combined	Subsurface Soil	Copper	mg/kg dw	65	100%	65	2.80	13.04	62.00	14.83
Combined	Subsurface Soil	Vanadium	mg/kg dw	65	100%	65	7.70	21.18	50.00	22.77
Combined	Subsurface Soil	Zinc	mg/kg dw	65	100%	65	23.50	102.55	1800.00	91.06
Combined	Subsurface Soil	Calcium	mg/kg dw	65	100%	65	2400.00	18037.69	130000.00	17816.28
Combined	Subsurface Soil	Selenium	mg/kg dw	65	2%	13	0.48	0.50	0.51	0.50
Combined	Subsurface Soil	Total PCBs	ug/kg dw	65	17%	65	4.30	11.78	53.90	12.35
Combined	Subsurface Soil	Heptachlor epoxide	ug/kg dw	65	5%	3	0.08	0.33	0.57	0.57
Combined	Subsurface Soil	Endosulfan sulfate	ug/kg dw	65	8%	5	0.32	0.58	1.00	1.00
Combined	Subsurface Soil	beta-BHC	ug/kg dw	65	2%	1	0.20	0.20	0.20	0.20
Combined	Subsurface Soil	delta-BHC	ug/kg dw	65	5%	3	0.12	0.16	0.23	0.23
Combined	Subsurface Soil	4,4'-DDT	ug/kg dw	65	2%	1	0.27	0.27	0.27	0.27
Combined	Subsurface Soil	Alpha Chlordane	ug/kg dw	65	2%	1	0.58	0.58	0.58	0.58

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.



**Table 4-16 (2 of 3)**  
**Floodplain Soils - Subsurface Sample Summary**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Subsurface Soil	Endrin ketone	ug/kg dw	65	5%	3	0.18	0.25	0.29	0.29
Combined	Subsurface Soil	Dieldrin	ug/kg dw	65	6%	4	0.12	0.76	1.30	1.30
Combined	Subsurface Soil	Methoxychlor	ug/kg dw	65	5%	3	1.60	3.93	7.60	7.60
Combined	Subsurface Soil	4,4'-DDD	ug/kg dw	65	2%	1	0.53	0.53	0.53	0.53
Combined	Subsurface Soil	4,4'-DDE	ug/kg dw	65	6%	7	0.14	1.07	1.70	1.70
Combined	Subsurface Soil	Hepachlor	ug/kg dw	65	2%	1	0.26	0.26	0.26	0.26
Combined	Subsurface Soil	bis(2-Ethylhexyl)phthalate	ug/kg dw	65	43%	65	45.00	371.01	8700.00	223.61
Combined	Subsurface Soil	Di-n-octylphthalate	ug/kg dw	65	2%	64	90.00	100.08	117.50	117.50
Combined	Subsurface Soil	Anthracene	ug/kg dw	65	8%	65	58.00	184.44	5400.00	139.22
Combined	Subsurface Soil	Pyrene	ug/kg dw	65	11%	65	56.00	419.18	18000.00	197.99
Combined	Subsurface Soil	Dibenzofuran	ug/kg dw	65	3%	65	90.00	115.81	1100.00	116.49
Combined	Subsurface Soil	Benzo(g,h,i)perylene	ug/kg dw	65	15%	65	10.50	105.10	630.00	116.58
Combined	Subsurface Soil	Indeno(1,2,3-cd)pyrene	ug/kg dw	65	9%	65	80.00	160.34	3500.00	138.15
Combined	Subsurface Soil	Benzo(b)fluoranthene	ug/kg dw	65	11%	65	28.00	258.58	9800.00	159.15
Combined	Subsurface Soil	Fluorethane	ug/kg dw	65	14%	65	54.00	501.38	23000.00	208.85
Combined	Subsurface Soil	Benzo(k)fluoranthene	ug/kg dw	65	6%	65	36.00	211.90	6300.00	154.75
Combined	Subsurface Soil	Acenaphthylene	ug/kg dw	65	3%	65	49.00	108.87	720.00	112.07
Combined	Subsurface Soil	Chrysene	ug/kg dw	65	15%	65	39.00	283.42	11000.00	166.30
Combined	Subsurface Soil	Benzo(e)pyrene	ug/kg dw	65	8%	65	34.00	154.22	5600.00	92.61
Combined	Subsurface Soil	Dibenzo(a,h)anthracene	ug/kg dw	65	8%	65	46.50	86.45	1900.00	74.70
Combined	Subsurface Soil	Benzo(a)anthracene	ug/kg dw	65	15%	65	33.00	295.03	12000.00	166.36
Combined	Subsurface Soil	Acenaphthene	ug/kg dw	65	5%	65	41.00	114.05	1000.00	116.26
Combined	Subsurface Soil	Di-n-butylphthalate	ug/kg dw	65	9%	65	45.50	98.29	120.00	101.75
Combined	Subsurface Soil	Phenanthrene	ug/kg dw	65	14%	65	31.00	346.02	14000.00	184.91
Combined	Subsurface Soil	Fluorene	ug/kg dw	65	5%	65	36.00	128.67	2000.00	122.51
Combined	Subsurface Soil	Carbazole	ug/kg dw	65	5%	65	36.00	111.36	820.00	114.90
Combined	Subsurface Soil	Perchlorophenol	ug/kg dw	65	18%	65	223.40	261.08	553.18	268.43
Combined	Subsurface Soil	Naphthalene	ug/kg dw	65	5%	3	41.00	51.33	64.00	64.00
Combined	Subsurface Soil	2-Methylnaphthalene	ug/kg dw	65	2%	65	90.00	101.04	160.00	160.00
Combined	Subsurface Soil	Toluene	ug/kg dw	65	8%	65	1.80	3.21	6.60	3.34
Combined	Subsurface Soil	Chlorobenzene	ug/kg dw	65	3%	65	2.40	3.22	10.00	3.35
Combined	Subsurface Soil	Xylenes, Total	ug/kg dw	65	2%	64	2.40	3.10	4.30	3.19
Combined	Subsurface Soil	2-Hexanone	ug/kg dw	65	2%	1	3.50	3.50	3.50	3.50
Combined	Subsurface Soil	Acetone	ug/kg dw	65	22%	65	7.20	50.71	310.00	54.81
Combined	Subsurface Soil	Benzene	ug/kg dw	65	6%	48	0.98	2.88	3.20	2.96

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-16 (3 of 3)**  
**Floodplain Soils - Subsurface Sample Summary**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Combined	Subsurface Soil	Methylene chloride (Dichloromethane)	ug/kg dw	65	2%	4	2.40	2.40	2.40	2.40
Combined	Subsurface Soil	Carbon disulfide	ug/kg dw	65	5%	65	2.40	3.23	7.80	3.37
Combined	Subsurface Soil	2-Butanone (MEK)	ug/kg dw	65	11%	65	5.70	15.71	25.00	16.55
Combined	Subsurface Soil	Trichloroethene	ug/kg dw	65	5%	65	2.40	3.17	7.40	3.28

Table 4-17 (1 of 2)  
Sediment Sampling Summary - Creek Segment B

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSB	Sediment	1998 Total TEQ w/ EMPC as ND	ppb	3	100%	3	4.31	8.80	12.50	12.50
CSB	Sediment	Aluminum	mg/kg dw	3	100%	3	6550.00	8950.00	12000.00	12000.00
CSB	Sediment	Iron	mg/kg dw	3	100%	3	13000.00	22333.33	28000.00	28000.00
CSB	Sediment	Lead	mg/kg dw	3	100%	3	560.00	770.00	1000.00	1000.00
CSB	Sediment	Magnesium	mg/kg dw	3	100%	3	10000.00	13666.67	20000.00	20000.00
CSB	Sediment	Manganese	mg/kg dw	3	100%	3	210.00	228.33	245.00	245.00
CSB	Sediment	Mercury	mg/kg dw	3	100%	3	0.76	1.22	1.50	1.50
CSB	Sediment	Molybdenum	mg/kg dw	3	100%	3	4.30	5.37	7.00	7.00
CSB	Sediment	Nickel	mg/kg dw	3	100%	3	77.50	319.17	500.00	500.00
CSB	Sediment	Potassium	mg/kg dw	3	100%	3	1650.00	1916.67	2400.00	2400.00
CSB	Sediment	Silver	mg/kg dw	3	100%	3	6.70	10.20	18.00	18.00
CSB	Sediment	Thallium	mg/kg dw	3	33%	3	1.15	1.48	2.10	2.10
CSB	Sediment	Antimony	mg/kg dw	3	100%	3	6.30	7.33	8.90	8.90
CSB	Sediment	Arsenic	mg/kg dw	3	100%	3	25.00	32.00	38.00	38.00
CSB	Sediment	Barium	mg/kg dw	3	100%	3	750.00	1916.67	3300.00	3300.00
CSB	Sediment	Cadmium	mg/kg dw	3	100%	3	15.00	21.67	25.00	25.00
CSB	Sediment	Chromium	mg/kg dw	3	100%	3	41.50	65.17	78.00	78.00
CSB	Sediment	Cobalt	mg/kg dw	3	100%	3	6.95	9.82	12.00	12.00
CSB	Sediment	Copper	mg/kg dw	13	100%	13	480.00	6408.85	19000.00	19000.00
CSB	Sediment	Vanadium	mg/kg dw	3	100%	3	27.50	35.17	41.00	41.00
CSB	Sediment	Zinc	mg/kg dw	13	100%	13	530.00	11440.77	26000.00	26000.00
CSB	Sediment	Calcium	mg/kg dw	3	100%	3	87000.00	122333.33	180000.00	180000.00
CSB	Sediment	Selenium	mg/kg dw	3	100%	3	2.90	3.83	5.10	5.10
CSB	Sediment	Hydrocarbons as DRO	mg/kg dw	10	100%	10	67.00	1648.70	5200.00	5200.00
CSB	Sediment	Copper	mg/kg dw	13	100%	13	480.00	6408.85	19000.00	19000.00
CSB	Sediment	Zinc	mg/kg dw	13	100%	13	530.00	11440.77	26000.00	26000.00
CSB	Sediment	Hydrocarbons as GRO	mg/kg dw	10	90%	10	0.15	3.02	8.90	8.90
CSB	Sediment	Total Organic Carbon	mg/kg dw	13	100%	13	25000.00	83000.00	370000.00	151328.18
CSB	Sediment	Total PCBs	ug/kg dw	13	100%	13	422.10	39295.35	226140.00	226140.00
CSB	Sediment	Endosulfan sulfate	ug/kg dw	3	100%	3	98.00	170.83	284.50	284.50
CSB	Sediment	Aldrin	ug/kg dw	3	100%	3	410.00	830.00	1100.00	1100.00
CSB	Sediment	Gamma Chlordane	ug/kg dw	3	33%	3	165.00	378.33	720.00	720.00
CSB	Sediment	4,4'-DDD	ug/kg dw	3	33%	1	150.00	150.00	150.00	150.00
CSB	Sediment	Endrin aldehyde	ug/kg dw	3	33%	2	325.00	400.00	475.00	475.00
CSB	Sediment	Heptachlor	ug/kg dw	3	33%	3	165.00	300.00	500.00	500.00
CSB	Sediment	1,4-Dichlorobenzene	ug/kg dw	3	67%	2	520.00	785.00	1050.00	1050.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-17 (cont.)  
Sediment Sampling Summary - Creek Segment B**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSB	Sediment	4-Chloroaniline	ug/kg dw	3	33%	1	830.00	830.00	830.00	830.00
CSB	Sediment	bis(2-Ethylhexyl)phthalate	ug/kg dw	3	33%	3	1300.00	1666.67	2050.00	2050.00
CSB	Sediment	1,2,4-Trichlorobenzene	ug/kg dw	3	33%	1	770.00	770.00	770.00	770.00
CSB	Sediment	Pyrene	ug/kg dw	3	100%	3	2000.00	2200.00	2400.00	2400.00
CSB	Sediment	Benzo(g,h,i)perylene	ug/kg dw	3	100%	3	790.00	1181.67	1600.00	1600.00
CSB	Sediment	Indeno(1,2,3-cd)pyrene	ug/kg dw	3	67%	2	1000.00	1100.00	1200.00	1200.00
CSB	Sediment	Benzo(b)fluoranthene	ug/kg dw	3	100%	3	1100.00	1500.00	2000.00	2000.00
CSB	Sediment	Fluoranthene	ug/kg dw	3	100%	3	1800.00	1900.00	2000.00	2000.00
CSB	Sediment	Benzo(k)fluoranthene	ug/kg dw	3	100%	3	920.00	1243.33	1800.00	1800.00
CSB	Sediment	Chrysene	ug/kg dw	3	100%	3	1100.00	1398.33	1800.00	1800.00
CSB	Sediment	Benzo(a)Pyrene	ug/kg dw	3	100%	3	730.00	1021.67	1200.00	1200.00
CSB	Sediment	Benzo(a)anthracene	ug/kg dw	3	100%	3	680.00	776.67	870.00	870.00
CSB	Sediment	Phenanthrene	ug/kg dw	3	100%	3	910.00	965.00	1055.00	1055.00
CSB	Sediment	Pentachlorophenol	ug/kg dw	3	100%	3	3360.00	4470.42	6023.25	6023.25
CSB	Sediment	Naphthalene	ug/kg dw	3	33%	1	380.00	380.00	380.00	380.00
CSB	Sediment	1,2-Dichlorobenzene	ug/kg dw	3	33%	1	735.00	735.00	735.00	735.00
CSB	Sediment	Toluene	ug/kg dw	3	33%	3	11.50	16.83	20.00	20.00
CSB	Sediment	Chlorobenzene	ug/kg dw	3	100%	3	20.00	32.50	51.50	51.50
CSB	Sediment	2-Hexanone	ug/kg dw	3	33%	1	21.00	21.00	21.00	21.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4 (1 of 2)  
Sediment Sampling Summary - Creek Segment F

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSF	Sediment	1998 Total TEQ w/ EMPC as ND	ppb	3	100%	3	0.14	0.22	0.33	0.33
CSF	Sediment	2,4-D	ug/kg dw	3	33%	1	23.00	23.00	23.00	23.00
CSF	Sediment	Aluminum	mg/kg dw	3	100%	3	7800.00	12833.33	17000.00	17000.00
CSF	Sediment	Iron	mg/kg dw	3	100%	3	14000.00	20666.67	28000.00	28000.00
CSF	Sediment	Lead	mg/kg dw	3	100%	3	110.00	180.00	320.00	320.00
CSF	Sediment	Magnesium	mg/kg dw	3	100%	3	4100.00	5400.00	8800.00	8800.00
CSF	Sediment	Manganese	mg/kg dw	3	100%	3	170.00	303.33	510.00	510.00
CSF	Sediment	Mercury	mg/kg dw	3	100%	3	0.30	0.62	1.10	1.10
CSF	Sediment	Molybdenum	mg/kg dw	3	100%	3	0.70	1.72	3.70	3.70
CSF	Sediment	Nickel	mg/kg dw	3	100%	3	80.00	220.00	390.00	390.00
CSF	Sediment	Potassium	mg/kg dw	3	100%	3	1800.00	2400.00	2800.00	2800.00
CSF	Sediment	Antimony	mg/kg dw	2	100%	2	2.50	2.55	2.60	2.60
CSF	Sediment	Arsenic	mg/kg dw	3	100%	3	8.00	14.00	19.00	19.00
CSF	Sediment	Barium	mg/kg dw	3	100%	3	150.00	223.33	270.00	270.00
CSF	Sediment	Beryllium	mg/kg dw	3	100%	3	0.53	0.76	0.89	0.89
CSF	Sediment	Cadmium	mg/kg dw	3	100%	3	7.40	22.80	47.00	47.00
CSF	Sediment	Chromium	mg/kg dw	3	100%	3	19.00	29.00	38.00	38.00
CSF	Sediment	Cobalt	mg/kg dw	3	100%	3	5.50	9.83	13.00	13.00
CSF	Sediment	Copper	mg/kg dw	43	100%	43	10.00	549.51	5400.00	1591.01
CSF	Sediment	Vanadium	mg/kg dw	3	100%	3	25.00	39.00	51.00	51.00
CSF	Sediment	Zinc	mg/kg dw	43	100%	43	50.00	2704.65	11000.00	9138.15
CSF	Sediment	Calcium	mg/kg dw	3	100%	3	11000.00	11866.67	13000.00	13000.00
CSF	Sediment	Hydrocarbons as DRO	mg/kg dw	40	100%	40	2.70	88.68	820.00	208.48
CSF	Sediment	Copper	mg/kg dw	43	100%	43	10.00	549.51	5400.00	1591.01
CSF	Sediment	Zinc	mg/kg dw	43	100%	43	50.00	2704.65	11000.00	9138.15
CSF	Sediment	Hydrocarbons as GRO	mg/kg dw	40	35%	40	0.10	1.01	31.00	0.50
CSF	Sediment	Total Organic Carbon	mg/kg dw	43	100%	43	11000.00	39430.23	140000.00	47334.36
CSF	Sediment	Total PCBs	ug/kg dw	43	65%	43	10.00	438.79	6290.00	1327.99
CSF	Sediment	Heptachlor epoxide	ug/kg dw	3	67%	2	0.51	2.88	5.40	5.40
CSF	Sediment	Endosulfan sulfate	ug/kg dw	3	33%	1	2.80	2.80	2.80	2.80
CSF	Sediment	Aldrin	ug/kg dw	3	33%	1	4.10	4.10	4.10	4.10
CSF	Sediment	delta-BHC	ug/kg dw	3	33%	1	0.34	0.34	0.34	0.34
CSF	Sediment	Endosulfan II	ug/kg dw	3	100%	3	1.80	5.13	8.10	8.10
CSF	Sediment	4,4'-DDT	ug/kg dw	3	33%	1	4.50	4.50	4.50	4.50
CSF	Sediment	Alpha Chlordane	ug/kg dw	3	100%	3	0.84	3.68	5.30	5.30
CSF	Sediment	Gamma Chlordane	ug/kg dw	3	100%	3	2.40	8.97	17.00	17.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-18 (2 of 2)**  
**Sediment Sampling Summary - Creek Segment F**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSF	Sediment	Endrin ketone	ug/kg dw	3	100%	3	3.80	7.00	10.00	10.00
CSF	Sediment	Dieldrin	ug/kg dw	3	67%	2	0.99	5.15	9.30	9.30
CSF	Sediment	Endrin	ug/kg dw	3	67%	2	1.70	1.70	1.70	1.70
CSF	Sediment	Methoxychlor	ug/kg dw	3	100%	3	7.30	15.10	24.00	24.00
CSF	Sediment	4,4'-DDD	ug/kg dw	3	33%	1	3.80	3.80	3.80	3.80
CSF	Sediment	4,4'-DDE	ug/kg dw	3	100%	3	2.50	7.20	11.00	11.00
CSF	Sediment	Endrin aldehyde	ug/kg dw	3	100%	3	3.60	8.87	14.00	14.00
CSF	Sediment	Heptachlor	ug/kg dw	3	33%	1	0.93	0.93	0.93	0.93
CSF	Sediment	Endosulfan I	ug/kg dw	3	100%	3	1.20	2.97	5.70	5.70
CSF	Sediment	Fluoranthene	ug/kg dw	3	67%	2	120.00	125.00	130.00	130.00
CSF	Sediment	Chrysene	ug/kg dw	3	33%	1	74.00	74.00	74.00	74.00
CSF	Sediment	Ethylbenzene	ug/kg dw	3	33%	2	8.50	9.75	11.00	11.00

NOTE: Site concentration is the lower of the 95% UCI or the maximum detected concentration.

Figure 4-19 (1 of 2)  
Sediment Sampling Summary - Creek Segment C

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSC	Sediment	1998 Total TEQ w/ EMPC as ND	ppb	2	100%	2	1.63	2.27	2.91	2.91
CSC	Sediment	Aluminum	mg/kg dw	3	100%	3	9700.00	12233.33	15000.00	15000.00
CSC	Sediment	Iron	mg/kg dw	3	100%	3	21000.00	24000.00	27000.00	27000.00
CSC	Sediment	Lead	mg/kg dw	3	100%	3	270.00	360.00	480.00	480.00
CSC	Sediment	Magnesium	mg/kg dw	3	100%	3	3600.00	5166.67	8400.00	8400.00
CSC	Sediment	Manganese	mg/kg dw	3	100%	3	240.00	286.67	330.00	330.00
CSC	Sediment	Mercury	mg/kg dw	3	100%	3	0.58	0.83	0.88	0.88
CSC	Sediment	Molybdenum	mg/kg dw	3	67%	3	0.85	2.15	3.40	3.40
CSC	Sediment	Nickel	mg/kg dw	3	100%	3	370.00	500.00	580.00	580.00
CSC	Sediment	Potassium	mg/kg dw	3	100%	3	2100.00	2500.00	3000.00	3000.00
CSC	Sediment	Silver	mg/kg dw	3	100%	3	1.20	1.53	1.80	1.80
CSC	Sediment	Antimony	mg/kg dw	3	100%	3	1.30	1.77	2.20	2.20
CSC	Sediment	Arsenic	mg/kg dw	3	100%	3	16.00	20.33	28.00	28.00
CSC	Sediment	Barium	mg/kg dw	3	100%	3	470.00	650.00	800.00	800.00
CSC	Sediment	Cadmium	mg/kg dw	3	100%	3	16.00	18.33	20.00	20.00
CSC	Sediment	Chromium	mg/kg dw	3	100%	3	47.00	63.33	83.00	83.00
CSC	Sediment	Cobalt	mg/kg dw	3	100%	3	9.70	12.90	17.00	17.00
CSC	Sediment	Copper	mg/kg dw	15	100%	15	840.00	8299.33	17250.00	14389.67
CSC	Sediment	Vanadium	mg/kg dw	3	100%	3	34.00	39.33	48.00	48.00
CSC	Sediment	Zinc	mg/kg dw	15	100%	15	2300.00	12870.00	41350.00	28298.63
CSC	Sediment	Calcium	mg/kg dw	3	100%	3	23000.00	32666.67	47000.00	47000.00
CSC	Sediment	Hydrocarbons as DRO	mg/kg dw	12	100%	12	180.00	1492.08	3900.00	3473.27
CSC	Sediment	Copper	mg/kg dw	15	100%	15	840.00	8299.33	17250.00	14389.67
CSC	Sediment	Zinc	mg/kg dw	15	100%	15	2300.00	12870.00	41350.00	28298.63
CSC	Sediment	Hydrocarbons as GRO	mg/kg dw	12	92%	12	0.15	3.10	9.05	9.05
CSC	Sediment	Total Organic Carbon	mg/kg dw	15	100%	15	34000.00	87900.00	180000.00	111868.40
CSC	Sediment	Total PCBs	ug/kg dw	15	100%	15	160.00	11337.80	48250.00	48250.00
CSC	Sediment	Endosulfan sulfate	ug/kg dw	3	67%	2	9.00	12.50	16.00	16.00
CSC	Sediment	Aldrin	ug/kg dw	3	100%	3	25.00	43.67	64.00	64.00
CSC	Sediment	delta-BHC	ug/kg dw	3	33%	2	10.50	14.25	18.00	18.00
CSC	Sediment	Alpha Chlordane	ug/kg dw	3	100%	3	37.00	70.33	120.00	120.00
CSC	Sediment	Gamma Chlordane	ug/kg dw	3	100%	3	110.00	168.67	250.00	250.00
CSC	Sediment	4,4'-DDD	ug/kg dw	3	33%	1	28.00	28.00	28.00	28.00
CSC	Sediment	4,4'-DDE	ug/kg dw	3	33%	1	51.00	51.00	51.00	51.00
CSC	Sediment	Heptachlor	ug/kg dw	3	67%	2	9.10	9.40	9.70	9.70
CSC	Sediment	Pyrene	ug/kg dw	3	100%	3	660.00	1200.00	2000.00	2000.00

NOTE: Site contamination is the lower of the 95% UCL or the maximum detected concentration.

Figure 4-19 (1 of 2)  
Sediment Sampling Summary - Creek Segment C

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSC	Sediment	Benzo(g,h,i)perylene	ug/kg dw	3	33%	2	1400.00	1400.00	1400.00	1400.00
CSC	Sediment	Benzo(b)fluoranthene	ug/kg dw	3	100%	3	600.00	1093.33	2000.00	2000.00
CSC	Sediment	Fluoranthene	ug/kg dw	3	100%	3	760.00	1260.00	2200.00	2200.00
CSC	Sediment	Benzo(k)fluoranthene	ug/kg dw	3	67%	2	390.00	795.00	1200.00	1200.00
CSC	Sediment	Chrysene	ug/kg dw	3	100%	3	500.00	880.00	1500.00	1500.00
CSC	Sediment	Benzo(a)pyrene	ug/kg dw	3	33%	3	750.00	1016.67	1400.00	1400.00
CSC	Sediment	Benzo(a)anthracene	ug/kg dw	3	67%	2	530.00	710.00	890.00	890.00
CSC	Sediment	Phenanthrene	ug/kg dw	3	100%	3	320.00	563.33	840.00	840.00
CSC	Sediment	Perinaphthene	ug/kg dw	3	100%	3	3511.50	4258.90	5011.50	5011.50
CSC	Sediment	Acetone	ug/kg dw	3	100%	3,000	96.00	108.67	130.00	130.00
CSC	Sediment	2-Butanone (MEK)	ug/kg dw	3	100%	3,000	28.00	32.00	37.00	37.00

NOTE: Site contamination is the lower of the 95% UCL or the maximum detected concentration.



Table 4. (1 of 2)  
Sediment Sampling Summary - Creek Segment D

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSD	Sediment	1998 Total TEQ w/ EMPC as ND	ppb	3	100%	3	0.44	0.58	0.67	0.67
CSD	Sediment	Dicamba	ug/kg dw	3	33%	1	13.00	13.00	13.00	13.00
CSD	Sediment	Aluminum	mg/kg dw	3	100%	3	13000.00	14000.00	16000.00	16000.00
CSD	Sediment	Iron	mg/kg dw	3	100%	3	18000.00	22000.00	25000.00	25000.00
CSD	Sediment	Lead	mg/kg dw	3	100%	3	170.00	220.00	280.00	280.00
CSD	Sediment	Magnesium	mg/kg dw	3	100%	3	6800.00	6833.33	7500.00	7500.00
CSD	Sediment	Manganese	mg/kg dw	3	100%	3	250.00	280.00	320.00	320.00
CSD	Sediment	Mercury	mg/kg dw	3	100%	3	0.35	0.42	0.50	0.50
CSD	Sediment	Nickel	mg/kg dw	3	100%	3	150.00	223.33	280.00	280.00
CSD	Sediment	Potassium	mg/kg dw	3	100%	3	2700.00	2833.33	3200.00	3200.00
CSD	Sediment	Arsenic	mg/kg dw	3	100%	3	10.00	14.33	17.00	17.00
CSD	Sediment	Barium	mg/kg dw	3	100%	3	310.00	363.33	400.00	400.00
CSD	Sediment	Cadmium	mg/kg dw	3	100%	3	10.00	12.67	15.00	15.00
CSD	Sediment	Chromium	mg/kg dw	3	100%	3	58.00	61.00	67.00	67.00
CSD	Sediment	Cobalt	mg/kg dw	3	100%	3	8.80	10.93	12.00	12.00
CSD	Sediment	Copper	mg/kg dw	12	100%	12	220.00	2543.33	18000.00	6337.89
CSD	Sediment	Vanadium	mg/kg dw	3	100%	3	37.00	44.00	51.00	51.00
CSD	Sediment	Zinc	mg/kg dw	12	100%	12	360.00	6071.67	18000.00	19000.00
CSD	Sediment	Calcium	mg/kg dw	3	100%	3	28000.00	28000.00	30000.00	30000.00
CSD	Sediment	Hydrocarbons as DRO	mg/kg dw	9	100%	9	30.00	398.67	1200.00	1200.00
CSD	Sediment	Copper	mg/kg dw	12	100%	12	220.00	2543.33	18000.00	6337.89
CSD	Sediment	Zinc	mg/kg dw	12	100%	12	380.00	6071.67	18000.00	19000.00
CSD	Sediment	Hydrocarbons as GRO	mg/kg dw	9	44%	9	0.17	0.39	0.84	0.88
CSD	Sediment	Total Organic Carbon	mg/kg dw	12	100%	12	31000.00	69833.33	170000.00	94299.44
CSD	Sediment	Total PCBs	ug/kg dw	12	100%	12	36.30	2818.86	10618.00	10618.00
CSD	Sediment	Aldrin	ug/kg dw	3	100%	3	2.70	7.77	11.00	11.00
CSD	Sediment	dieldrin-BHC	ug/kg dw	3	87%	3	1.50	8.17	16.00	16.00
CSD	Sediment	Alpha Chlordane	ug/kg dw	3	87%	3	14.00	18.33	26.00	26.00
CSD	Sediment	Gamma Chlordane	ug/kg dw	3	100%	3	6.70	28.23	49.00	49.00
CSD	Sediment	Endrin ketone	ug/kg dw	3	33%	1	5.50	5.50	5.50	5.50
CSD	Sediment	4,4'-DDE	ug/kg dw	3	100%	3	4.40	12.80	20.00	20.00
CSD	Sediment	Endrin aldehyde	ug/kg dw	3	33%	1	16.00	16.00	16.00	16.00
CSD	Sediment	bis(2-Ethylhexyl)phthalate	ug/kg dw	3	33%	1	1200.00	1200.00	1200.00	1200.00
CSD	Sediment	Pyrene	ug/kg dw	3	100%	3	950.00	1008.67	1100.00	1100.00
CSD	Sediment	Benzo(g,h,i)perylene	ug/kg dw	3	33%	1	660.00	660.00	660.00	660.00
CSD	Sediment	Benzo(b)fluoranthene	ug/kg dw	3	100%	3	780.00	886.67	970.00	970.00

NOTE: Site concentration is the lower of the 95% MCL or the maximum detected concentration.

**Table 4-20 (c of 2)**  
**Sediment Sampling Summary - Creek Segment D**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSD	Sediment	Fluoranthene	ug/kg dw	3	100%	3	1000.00	1133.33	1200.00	1200.00
CSD	Sediment	Benzofluoranthene	ug/kg dw	3	100%	3	520.00	596.67	660.00	660.00
CSD	Sediment	Chrysene	ug/kg dw	3	100%	3	670.00	733.33	790.00	790.00
CSD	Sediment	Benzofluoranthene	ug/kg dw	3	33%	1	560.00	560.00	560.00	560.00
CSD	Sediment	Benzofluoranthene	ug/kg dw	3	33%	1	420.00	420.00	420.00	420.00
CSD	Sediment	Phenanthrene	ug/kg dw	3	33%	1	410.00	410.00	410.00	410.00
CSD	Sediment	Perfluorobenzene	ug/kg dw	3	33%	1	3751.95	3751.95	3751.95	3751.95
CSD	Sediment	Acetone	ug/kg dw	3	100%	3	84.00	148.00	190.00	190.00
CSD	Sediment	2-Butanone (MEK)	ug/kg dw	3	100%	3	30.00	50.33	65.00	65.00

NOTE: Site concentration is the lower of the 95% MCL or the maximum detected concentration

Figure 4-21 (1 of 2)  
Sediment Sampling Summary - Creek Segment E

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSE	Sediment	1998 Total TEQ w/ EMPC as ND	ppb	3	100%	3	0.11	0.30	0.47	0.47
CSE	Sediment	2,4-D	ug/kg dw	3	33%	3	65.00	69.33	73.00	73.00
CSE	Sediment	2,4-DB	ug/kg dw	3	33%	3	65.00	65.00	150.00	150.00
CSE	Sediment	Aluminum	mg/kg dw	3	100%	3	11000.00	13000.00	15000.00	15000.00
CSE	Sediment	Iron	mg/kg dw	3	100%	3	17000.00	20333.33	24000.00	24000.00
CSE	Sediment	Lead	mg/kg dw	3	100%	3	140.00	213.33	310.00	310.00
CSE	Sediment	Magnesium	mg/kg dw	3	100%	3	7400.00	9866.67	13000.00	13000.00
CSE	Sediment	Manganese	mg/kg dw	3	100%	3	170.00	266.67	320.00	320.00
CSE	Sediment	Mercury	mg/kg dw	3	100%	3	0.30	0.37	0.51	0.51
CSE	Sediment	Molybdenum	mg/kg dw	3	100%	3	1.60	2.47	3.20	3.20
CSE	Sediment	Nickel	mg/kg dw	3	100%	3	51.00	123.67	190.00	190.00
CSE	Sediment	Potassium	mg/kg dw	3	100%	3	2400.00	2700.00	3100.00	3100.00
CSE	Sediment	Silver	mg/kg dw	3	67%	2	0.67	0.89	1.10	1.10
CSE	Sediment	Thallium	mg/kg dw	3	33%	3	1.30	1.57	1.80	1.80
CSE	Sediment	Antimony	mg/kg dw	3	67%	2	2.00	2.35	2.70	2.70
CSE	Sediment	Arsenic	mg/kg dw	3	100%	3	8.30	12.43	16.00	16.00
CSE	Sediment	Barium	mg/kg dw	3	100%	3	190.00	273.33	340.00	340.00
CSE	Sediment	Beryllium	mg/kg dw	3	67%	3	0.45	0.68	0.84	0.84
CSE	Sediment	Cadmium	mg/kg dw	3	100%	3	7.70	10.90	14.00	14.00
CSE	Sediment	Chromium	mg/kg dw	3	100%	3	31.00	50.33	71.00	71.00
CSE	Sediment	Cobalt	mg/kg dw	3	100%	3	7.40	8.87	10.00	10.00
CSE	Sediment	Copper	mg/kg dw	29	100%	29	24.00	2660.38	35000.00	13667.49
CSE	Sediment	Vanadium	mg/kg dw	3	100%	3	37.00	42.67	51.00	51.00
CSE	Sediment	Zinc	mg/kg dw	29	100%	29	490.00	11070.00	150000.00	17175.58
CSE	Sediment	Calcium	mg/kg dw	3	100%	3	26000.00	49666.67	80000.00	80000.00
CSE	Sediment	Hydrocarbons as DRO	mg/kg dw	26	96%	26	2.40	707.16	3600.00	3600.00
CSE	Sediment	Copper	mg/kg dw	29	100%	29	24.00	2660.38	35000.00	13667.49
CSE	Sediment	Zinc	mg/kg dw	29	100%	29	490.00	11070.00	150000.00	17175.58
CSE	Sediment	Hydrocarbons as GRO	mg/kg dw	26	65%	26	0.16	1.18	6.65	1.95
CSE	Sediment	Total Organic Carbon	mg/kg dw	29	100%	29	14000.00	48783.10	92000.00	55763.40
CSE	Sediment	Total PCBs	ug/kg dw	29	52%	29	8.00	916.83	8758.00	3636.79
CSE	Sediment	Heptachlor epoxide	ug/kg dw	3	33%	1	5.20	5.20	5.20	5.20
CSE	Sediment	Endosulfan sulfate	ug/kg dw	3	33%	1	10.00	10.00	10.00	10.00
CSE	Sediment	delta-BHC	ug/kg dw	3	33%	1	1.30	1.30	1.30	1.30
CSE	Sediment	Endosulfan II	ug/kg dw	3	67%	3	2.30	8.43	12.00	12.00
CSE	Sediment	4,4'-DDT	ug/kg dw	3	33%	1	9.30	9.30	9.30	9.30

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Figure 4-21 (p. of 2)  
Sediment Sampling Summary - Creek Segment E

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSE	Sediment	Alpha Chlordane	ug/kg dw	3	100%	3	2.50	4.43	6.90	6.90
CSE	Sediment	Gamma Chlordane	ug/kg dw	3	100%	3	5.10	8.33	14.00	14.00
CSE	Sediment	Endrin ketone	ug/kg dw	3	67%	3	6.80	11.60	17.00	17.00
CSE	Sediment	Dieldrin	ug/kg dw	3	100%	3	1.70	5.50	9.40	9.40
CSE	Sediment	Endrin	ug/kg dw	3	33%	1	4.60	4.60	4.60	4.60
CSE	Sediment	Methoxychlor	ug/kg dw	3	33%	1	39.00	39.00	39.00	39.00
CSE	Sediment	4,4'-DDE	ug/kg dw	3	100%	3	3.40	7.57	15.00	15.00
CSE	Sediment	Endrin aldehyde	ug/kg dw	3	67%	3	3.60	12.20	22.00	22.00
CSE	Sediment	Heptachlor	ug/kg dw	3	33%	1	0.53	0.53	0.53	0.53
CSE	Sediment	bis(2-Ethylhexyl)phthalate	ug/kg dw	3	67%	2	250.00	255.00	260.00	260.00
CSE	Sediment	Pyrene	ug/kg dw	3	100%	3	250.00	520.00	1000.00	1000.00
CSE	Sediment	Benzo(a,h)perylene	ug/kg dw	3	100%	3	140.00	220.00	350.00	350.00
CSE	Sediment	Indeno(1,2,3-cd)pyrene	ug/kg dw	3	100%	3	130.00	236.67	430.00	430.00
CSE	Sediment	Benzo(b)fluoranthene	ug/kg dw	3	100%	3	170.00	316.67	520.00	520.00
CSE	Sediment	Fluoranthene	ug/kg dw	3	100%	3	320.00	636.67	1200.00	1200.00
CSE	Sediment	Benzo(k)fluoranthene	ug/kg dw	3	67%	3	170.00	356.67	600.00	600.00
CSE	Sediment	Chrysene	ug/kg dw	3	100%	3	150.00	246.67	420.00	420.00
CSE	Sediment	Benzo(a)pyrene	ug/kg dw	3	100%	3	100.00	186.67	340.00	340.00
CSE	Sediment	Benzo(a)anthracene	ug/kg dw	3	100%	3	120.00	253.33	510.00	510.00
CSE	Sediment	Phenanthrene	ug/kg dw	3	67%	2	556.00	628.95	701.90	701.90
CSE	Sediment	Pentachlorophenol	ug/kg dw	3	33%	3	95.00	503.33	1200.00	1200.00
CSE	Sediment	Acalone	ug/kg dw	3	33%	3	47.00	214.00	520.00	520.00
CSE	Sediment	2-Butanone (MEK)	ug/kg dw	3	33%	3				

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-22**  
**Sediment Sampling Summary - Reference Areas**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
RA	Sediment	1998 Total TEQ w/ EMPC as ND	ug/kg dw	4	100%	4	0.01	0.01	0.01	0.01
RA	Sediment	2,4-D	ug/kg dw	4	25%	4	8.50	10.13	12.00	12.00
RA	Sediment	Aluminum	mg/kg dw	4	100%	4	12000.00	14500.00	19000.00	19000.00
RA	Sediment	Iron	mg/kg dw	4	100%	4	17500.00	20825.00	24000.00	24000.00
RA	Sediment	Lead	mg/kg dw	4	100%	4	16.50	21.88	26.00	26.00
RA	Sediment	Magnesium	mg/kg dw	4	100%	4	3250.00	5137.50	6500.00	6500.00
RA	Sediment	Manganese	mg/kg dw	4	100%	4	570.00	707.50	770.00	770.00
RA	Sediment	Mercury	mg/kg dw	4	100%	4	0.04	0.05	0.06	0.06
RA	Sediment	Molybdenum	mg/kg dw	4	100%	4	0.37	0.45	0.53	0.53
RA	Sediment	Nickel	mg/kg dw	4	100%	4	17.50	21.38	26.00	26.00
RA	Sediment	Potassium	mg/kg dw	4	100%	4	1600.00	2100.00	2600.00	2600.00
RA	Sediment	Antimony	mg/kg dw	3	67%	2	1.30	1.38	1.45	1.45
RA	Sediment	Arsenic	mg/kg dw	4	100%	4	6.70	7.18	8.00	8.00
RA	Sediment	Barium	mg/kg dw	4	100%	4	165.00	208.25	230.00	230.00
RA	Sediment	Beryllium	mg/kg dw	4	100%	4	0.82	0.78	1.00	1.00
RA	Sediment	Cadmium	mg/kg dw	4	100%	4	0.29	0.42	0.65	0.65
RA	Sediment	Chromium	mg/kg dw	4	100%	4	17.00	20.00	25.00	25.00
RA	Sediment	Cobalt	mg/kg dw	4	100%	4	7.10	8.60	10.00	10.00
RA	Sediment	Copper	mg/kg dw	4	100%	4	16.00	19.00	23.00	23.00
RA	Sediment	Vanadium	mg/kg dw	4	100%	4	29.50	34.88	44.00	44.00
RA	Sediment	Zinc	mg/kg dw	4	100%	4	59.00	83.00	96.00	96.00
RA	Sediment	Calcium	mg/kg dw	4	100%	4	12000.00	13500.00	18000.00	18000.00
RA	Sediment	Total Organic Carbon	mg/kg dw	4	100%	4	12000.00	17000.00	23000.00	23000.00
RA	Sediment	Pentachlorophenol	ug/kg dw	4	25%	1	375.95	375.95	375.95	375.95
RA	Sediment	Acetone	ug/kg dw	4	75%	4	47.50	77.75	160.00	160.00
RA	Sediment	2-Butanone (MEK)	ug/kg dw	4	75%	4	14.00	24.94	40.00	40.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-23 (continued)  
Sediment Sampling Summary - Site M

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
M	Sediment	1998 Total TEQ w/ EMPC as ND	ug/kg dw	1	100%	1	3.80	3.80	3.80	3.80
M	Sediment	Aluminum	mg/kg dw	1	100%	1	8900.00	8900.00	8900.00	8900.00
M	Sediment	Iron	mg/kg dw	1	100%	1	34000.00	34000.00	34000.00	34000.00
M	Sediment	Lead	mg/kg dw	1	100%	1	530.00	530.00	530.00	530.00
M	Sediment	Magnesium	mg/kg dw	1	100%	1	7400.00	7400.00	7400.00	7400.00
M	Sediment	Manganese	mg/kg dw	1	100%	1	370.00	370.00	370.00	370.00
M	Sediment	Mercury	mg/kg dw	1	100%	1	1.00	1.00	1.00	1.00
M	Sediment	Molybdenum	mg/kg dw	1	100%	1	17.00	17.00	17.00	17.00
M	Sediment	Nickel	mg/kg dw	1	100%	1	190.00	190.00	190.00	190.00
M	Sediment	Potassium	mg/kg dw	1	100%	1	2000.00	2000.00	2000.00	2000.00
M	Sediment	Silver	mg/kg dw	1	100%	1	7.30	7.30	7.30	7.30
M	Sediment	Antimony	mg/kg dw	1	100%	1	6.60	6.60	6.60	6.60
M	Sediment	Arsenic	mg/kg dw	1	100%	1	36.00	36.00	36.00	36.00
M	Sediment	Barium	mg/kg dw	1	100%	1	700.00	700.00	700.00	700.00
M	Sediment	Cadmium	mg/kg dw	1	100%	1	17.00	17.00	17.00	17.00
M	Sediment	Chromium	mg/kg dw	1	100%	1	48.00	48.00	48.00	48.00
M	Sediment	Cobalt	mg/kg dw	1	100%	1	15.00	15.00	15.00	15.00
M	Sediment	Copper	mg/kg dw	1	100%	1	4200.00	4200.00	4200.00	4200.00
M	Sediment	Vanadium	mg/kg dw	1	100%	1	45.00	45.00	45.00	45.00
M	Sediment	Zinc	mg/kg dw	1	100%	1	2400.00	2400.00	2400.00	2400.00
M	Sediment	Calcium	mg/kg dw	1	100%	1	100000.00	100000.00	100000.00	100000.00
M	Sediment	Selenium	mg/kg dw	1	100%	1	3.80	3.80	3.80	3.80
M	Sediment	Total Organic Carbon	mg/kg dw	1	100%	1	75000.00	75000.00	75000.00	75000.00
M	Sediment	Total PCBs	ug/kg dw	1	100%	1	12200.00	12200.00	12200.00	12200.00
M	Sediment	Endosulfan sulfate	ug/kg dw	1	100%	1	50.00	50.00	50.00	50.00
M	Sediment	Aldrin	ug/kg dw	1	100%	1	120.00	120.00	120.00	120.00
M	Sediment	4,4'-DDT	ug/kg dw	1	100%	1	44.00	44.00	44.00	44.00
M	Sediment	Gamma Chlordane	ug/kg dw	1	100%	1	140.00	140.00	140.00	140.00
M	Sediment	Endrin ketone	ug/kg dw	1	100%	1	200.00	200.00	200.00	200.00
M	Sediment	4,4'-DDE	ug/kg dw	1	100%	1	110.00	110.00	110.00	110.00
M	Sediment	Heptachlor	ug/kg dw	1	100%	1	59.00	59.00	59.00	59.00
M	Sediment	4-Chloroaniline	ug/kg dw	1	100%	1	2400.00	2400.00	2400.00	2400.00
M	Sediment	bis(2-Ethylhexyl)phthalate	ug/kg dw	1	100%	1	1400.00	1400.00	1400.00	1400.00
M	Sediment	Pyrene	ug/kg dw	1	100%	1	2200.00	2200.00	2200.00	2200.00
M	Sediment	Benzo(g,h,i)perylene	ug/kg dw	1	100%	1	1300.00	1300.00	1300.00	1300.00
M	Sediment	Benzo(b)fluoranthene	ug/kg dw	1	100%	1	1500.00	1500.00	1500.00	1500.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration



**Table 4-24**  
**Sediment Sampling Summary - Old Prairie du Pont Creek**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
PDC	Sediment	1998 Total TEQ w/ EMPC as ND	ug/kg dw	2	100%	2	0.00	0.00	0.00	0.00
PDC	Sediment	Aluminum	mg/kg dw	2	100%	2	9800.00	10900.00	12000.00	12000.00
PDC	Sediment	Iron	mg/kg dw	2	100%	2	16000.00	16500.00	17000.00	17000.00
PDC	Sediment	Lead	mg/kg dw	2	100%	2	15.50	15.75	18.00	18.00
PDC	Sediment	Magnesium	mg/kg dw	2	100%	2	2700.00	2800.00	2900.00	2900.00
PDC	Sediment	Manganese	mg/kg dw	2	100%	2	430.00	517.50	605.00	605.00
PDC	Sediment	Mercury	mg/kg dw	2	100%	2	0.02	0.02	0.03	0.03
PDC	Sediment	Molybdenum	mg/kg dw	2	100%	2	0.45	0.54	0.63	0.63
PDC	Sediment	Nickel	mg/kg dw	2	100%	2	15.00	15.75	18.50	18.50
PDC	Sediment	Potassium	mg/kg dw	2	100%	2	1200.00	1275.00	1350.00	1350.00
PDC	Sediment	Sodium	mg/kg dw	2	100%	2	75.50	83.75	92.00	92.00
PDC	Sediment	Arsenic	mg/kg dw	2	100%	2	7.00	7.10	7.20	7.20
PDC	Sediment	Barium	mg/kg dw	2	100%	2	135.00	137.50	140.00	140.00
PDC	Sediment	Beryllium	mg/kg dw	2	100%	2	0.48	0.52	0.56	0.56
PDC	Sediment	Chromium	mg/kg dw	2	100%	2	15.00	16.00	17.00	17.00
PDC	Sediment	Cobalt	mg/kg dw	2	100%	2	6.70	7.13	7.55	7.55
PDC	Sediment	Copper	mg/kg dw	2	100%	2	14.00	14.25	14.50	14.50
PDC	Sediment	Vanadium	mg/kg dw	2	100%	2	25.00	28.00	31.00	31.00
PDC	Sediment	Zinc	mg/kg dw	2	100%	2	58.00	59.50	61.00	61.00
PDC	Sediment	Calcium	mg/kg dw	2	100%	2	3650.00	4475.00	5300.00	5300.00
PDC	Sediment	Total Organic Carbon	mg/kg dw	2	100%	2	3600.00	4125.00	4650.00	4650.00
PDC	Sediment	Toluene	ug/kg dw	2	50%	1	5.35	5.35	5.35	5.35
PDC	Sediment	Acetone	ug/kg dw	2	100%	2	41.00	43.00	45.00	45.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.



Table 4 (1 of 2)  
Surface water Sampling Summary - Creek Segment B

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSB	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	3	100%	3	0.00	0.00	0.00	0.00
CSB	Surface Water	Aluminum	mg/l	3	100%	3	0.04	0.05	0.07	0.07
CSB	Surface Water	Iron	mg/l	3	33%	3	0.04	0.18	0.43	0.43
CSB	Surface Water	Lead	mg/l	3	100%	3	0.00	0.00	0.01	0.01
CSB	Surface Water	Magnesium	mg/l	3	100%	3	6.00	15.33	23.00	23.00
CSB	Surface Water	Manganese	mg/l	3	100%	3	0.01	0.02	0.03	0.03
CSB	Surface Water	Molybdenum	mg/l	3	100%	3	0.01	0.02	0.03	0.03
CSB	Surface Water	Nickel	mg/l	3	100%	3	0.01	0.01	0.02	0.02
CSB	Surface Water	Potassium	mg/l	3	100%	3	4.80	6.80	7.70	7.70
CSB	Surface Water	Sodium	mg/l	3	100%	3	28.00	39.67	54.00	54.00
CSB	Surface Water	Antimony	mg/l	3	33%	1	0.01	0.01	0.01	0.01
CSB	Surface Water	Arsenic	mg/l	3	67%	3	0.01	0.01	0.01	0.01
CSB	Surface Water	Barium	mg/l	3	100%	3	0.17	0.23	0.30	0.30
CSB	Surface Water	Cadmium	mg/l	3	33%	1	0.00	0.00	0.00	0.00
CSB	Surface Water	Copper	mg/l	3	100%	3	0.05	0.08	0.13	0.13
CSB	Surface Water	Zinc	mg/l	3	100%	3	0.05	0.09	0.13	0.13
CSB	Surface Water	Calcium	mg/l	3	100%	3	51.00	123.67	180.00	180.00
CSB	Surface Water	Ortho-Phosphate-P	mg/l	3	100%	3	0.02	0.06	0.09	0.09
CSB	Surface Water	Fluoride	mg/l	3	100%	3	0.22	0.36	0.55	0.55
CSB	Surface Water	Hardness as CaCO3	mg/l	3	100%	3	150.00	373.33	550.00	550.00
CSB	Surface Water	Total Phosphorus	mg/l	3	33%	3	0.05	0.07	0.11	0.11
CSB	Surface Water	pH (7.1,4.2) *	su	3	100%	3	7.80	8.03	8.50	8.50
CSB	Surface Water	Total Dissolved Solids	mg/l	3	100%	3	340.00	826.67	1200.00	1200.00
CSB	Surface Water	Heptachlor epoxide	ug/l	3	67%	2	0.00	0.00	0.01	0.01
CSB	Surface Water	Aldrin	ug/l	3	33%	1	0.00	0.00	0.00	0.00
CSB	Surface Water	alpha-BHC	ug/l	3	67%	3	0.01	0.02	0.02	0.02
CSB	Surface Water	beta-BHC	ug/l	3	67%	3	0.01	0.02	0.02	0.02
CSB	Surface Water	delta-BHC	ug/l	3	100%	3	0.01	0.01	0.02	0.02
CSB	Surface Water	Endosulfan II	ug/l	3	33%	1	0.01	0.01	0.01	0.01
CSB	Surface Water	4,4'-DDT	ug/l	3	33%	1	0.00	0.00	0.00	0.00
CSB	Surface Water	Gamma Chlordane	ug/l	3	67%	2	0.00	0.00	0.01	0.01
CSB	Surface Water	gamma-BHC (Lindane)	ug/l	3	67%	3	0.00	0.02	0.04	0.04
CSB	Surface Water	Dieldrin	ug/l	3	33%	1	0.00	0.00	0.00	0.00
CSB	Surface Water	4,4'-DDD	ug/l	3	33%	1	0.01	0.01	0.01	0.01
CSB	Surface Water	Endrin aldehyde	ug/l	3	33%	1	0.00	0.00	0.00	0.00
CSB	Surface Water	Heptachlor	ug/l	3	67%	2	0.00	0.00	0.00	0.00

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSB	Surface Water	Pentachlorophenol	ug/l	3	33%	3	1.50	1.58	1.75	1.75
CSB	Surface Water	Chlorobenzene	ug/l	3	33%	3	2.50	2.60	2.80	2.80
CSB	Surface Water	Acetone	ug/l	3	67%	2	14.00	16.00	18.00	18.00

**Table 4-26 (1 of 2)**  
**Surface-Water Sampling Summary - Creek Segment D**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSD	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	3	100%	3	0.00	0.00	0.00	0.00
CSD	Surface Water	Aluminum	mg/l	3	100%	3	0.33	0.69	1.40	1.40
CSD	Surface Water	Iron	mg/l	3	100%	3	0.96	1.29	1.80	1.80
CSD	Surface Water	Lead	mg/l	3	100%	3	0.01	0.01	0.02	0.02
CSD	Surface Water	Magnesium	mg/l	3	100%	3	6.00	6.38	6.60	6.60
CSD	Surface Water	Manganese	mg/l	3	100%	3	0.05	0.06	0.08	0.08
CSD	Surface Water	Molybdenum	mg/l	3	100%	3	0.00	0.00	0.01	0.01
CSD	Surface Water	Nickel	mg/l	3	100%	3	0.02	0.02	0.02	0.02
CSD	Surface Water	Potassium	mg/l	3	100%	3	5.00	5.70	6.30	6.30
CSD	Surface Water	Sodium	mg/l	3	100%	3	8.10	9.23	11.00	11.00
CSD	Surface Water	Arsenic	mg/l	3	33%	3	0.01	0.01	0.01	0.01
CSD	Surface Water	Barium	mg/l	3	100%	3	0.16	0.17	0.18	0.18
CSD	Surface Water	Chromium	mg/l	3	33%	3	0.01	0.01	0.01	0.01
CSD	Surface Water	Copper	mg/l	3	100%	3	0.02	0.02	0.03	0.03
CSD	Surface Water	Vanadium	mg/l	3	100%	3	0.00	0.01	0.01	0.01
CSD	Surface Water	Zinc	mg/l	3	100%	3	0.05	0.08	0.15	0.15
CSD	Surface Water	Calcium	mg/l	3	100%	3	48.00	49.17	50.00	50.00
CSD	Surface Water	Selenium	mg/l	3	33%	1	0.00	0.00	0.00	0.00
CSD	Surface Water	Ortho-Phosphate-P	mg/l	3	100%	3	0.06	0.07	0.08	0.08
CSD	Surface Water	Fluoride	mg/l	3	100%	3	0.20	0.25	0.30	0.30
CSD	Surface Water	Hardness as CaCO3	mg/l	3	100%	3	140.00	146.67	150.00	150.00
CSD	Surface Water	Total Phosphorus	mg/l	3	100%	3	0.21	0.23	0.25	0.25
CSD	Surface Water	pH (7.1.4.2) *	su	3	100%	3	7.60	7.83	8.00	8.00
CSD	Surface Water	Suspended Solids	mg/l	3	100%	3	26.00	32.50	44.00	44.00
CSD	Surface Water	Total Dissolved Solids	mg/l	3	100%	3	200.00	206.67	210.00	210.00
CSD	Surface Water	Total PCBs	ug/l	3	33%	1	0.06	0.06	0.06	0.06
CSD	Surface Water	Heptachlor epoxide	ug/l	3	100%	3	0.01	0.01	0.02	0.02
CSD	Surface Water	Endosulfan sulfate	ug/l	3	100%	3	0.00	0.02	0.03	0.03
CSD	Surface Water	Aldrin	ug/l	3	67%	2	0.00	0.01	0.01	0.01
CSD	Surface Water	alpha-BHC	ug/l	3	100%	3	0.00	0.01	0.02	0.02
CSD	Surface Water	beta-BHC	ug/l	3	100%	3	0.01	0.03	0.05	0.05
CSD	Surface Water	delta-BHC	ug/l	3	100%	3	0.00	0.01	0.01	0.01
CSD	Surface Water	Endosulfan II	ug/l	3	33%	1	0.03	0.03	0.03	0.03
CSD	Surface Water	4,4'-DDT	ug/l	3	100%	3	0.00	0.01	0.03	0.03
CSD	Surface Water	Gamma Chlordane	ug/l	3	33%	1	0.02	0.02	0.02	0.02
CSD	Surface Water	gamma-BHC (Lindane)	ug/l	3	100%	3	0.01	0.02	0.05	0.05

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSD	Surface Water	Endrin	ug/l	3	67%	2	0.01	0.02	0.03	0.03
CSD	Surface Water	Heptachlor	ug/l	3	100%	3	0.01	0.01	0.01	0.01
CSD	Surface Water	Endosulfan I	ug/l	3	33%	1	0.00	0.00	0.00	0.00
CSD	Surface Water	Acetone	ug/l	3	100%	3	11.00	13.17	17.00	17.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-27**  
**Surface-Water Sampling Summary - Creek Segment E**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSE	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	1	100%	1	0.00	0.00	0.00	0.00
CSE	Surface Water	Iron	mg/l	1	100%	1	1.20	1.20	1.20	1.20
CSE	Surface Water	Magnesium	mg/l	1	100%	1	15.00	15.00	15.00	15.00
CSE	Surface Water	Manganese	mg/l	1	100%	1	0.14	0.14	0.14	0.14
CSE	Surface Water	Potassium	mg/l	1	100%	1	4.80	4.80	4.80	4.80
CSE	Surface Water	Sodium	mg/l	1	100%	1	23.00	23.00	23.00	23.00
CSE	Surface Water	Barium	mg/l	1	100%	1	0.07	0.07	0.07	0.07
CSE	Surface Water	Copper	mg/l	1	100%	1	0.01	0.01	0.01	0.01
CSE	Surface Water	Zinc	mg/l	1	100%	1	0.07	0.07	0.07	0.07
CSE	Surface Water	Calcium	mg/l	1	100%	1	44.00	44.00	44.00	44.00
CSE	Surface Water	Ortho-Phosphate-P	mg/l	1	100%	1	0.37	0.37	0.37	0.37
CSE	Surface Water	Fluoride	mg/l	1	100%	1	0.75	0.75	0.75	0.75
CSE	Surface Water	Hardness as CaCO3	mg/l	1	100%	1	170.00	170.00	170.00	170.00
CSE	Surface Water	Total Phosphorus	mg/l	1	100%	1	0.37	0.37	0.37	0.37
CSE	Surface Water	pH	su	1	100%	1	7.10	7.10	7.10	7.10
CSE	Surface Water	Suspended Solids	mg/l	1	100%	1	7.00	7.00	7.00	7.00
CSE	Surface Water	Total Dissolved Solids	mg/l	1	100%	1	250.00	250.00	250.00	250.00
CSE	Surface Water	alpha-BHC	ug/l	1	100%	1	0.00	0.00	0.00	0.00
CSE	Surface Water	beta-BHC	ug/l	1	100%	1	0.01	0.01	0.01	0.01
CSE	Surface Water	delta-BHC	ug/l	1	100%	1	0.03	0.03	0.03	0.03
CSE	Surface Water	gamma-BHC (Lindane)	ug/l	1	100%	1	0.00	0.00	0.00	0.00
CSE	Surface Water	Pyrene	ug/l	1	100%	1	0.00	0.00	0.00	0.00
CSE	Surface Water	Fluoranthene	ug/l	1	100%	1	0.87	0.87	0.87	0.87
CSE	Surface Water	Phenanthrene	ug/l	1	100%	1	1.20	1.20	1.20	1.20
CSE	Surface Water		ug/l	1	100%	1	0.67	0.67	0.67	0.67

**Table 4-28**  
**Surface-Water Sampling Summary - Creek Segment F**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
CSF	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	3	100%	3	0.00	0.00	0.00	0.00
CSF	Surface Water	Aluminum	mg/l	3	100%	3	0.04	0.25	0.55	0.55
CSF	Surface Water	Iron	mg/l	3	100%	3	0.50	0.68	1.00	1.00
CSF	Surface Water	Lead	mg/l	3	67%	3	0.00	0.00	0.00	0.00
CSF	Surface Water	Magnesium	mg/l	3	100%	3	30.00	32.00	33.00	33.00
CSF	Surface Water	Manganese	mg/l	3	100%	3	0.08	0.11	0.14	0.14
CSF	Surface Water	Molybdenum	mg/l	3	33%	1	0.00	0.00	0.00	0.00
CSF	Surface Water	Nickel	mg/l	3	100%	3	0.01	0.01	0.02	0.02
CSF	Surface Water	Potassium	mg/l	3	100%	3	6.40	6.60	6.90	6.90
CSF	Surface Water	Sodium	mg/l	3	100%	3	21.00	21.33	22.00	22.00
CSF	Surface Water	Arsenic	mg/l	3	67%	2	0.00	0.00	0.00	0.00
CSF	Surface Water	Barium	mg/l	3	100%	3	0.12	0.13	0.13	0.13
CSF	Surface Water	Copper	mg/l	3	100%	3	0.00	0.01	0.01	0.01
CSF	Surface Water	Vanadium	mg/l	3	33%	1	0.00	0.00	0.00	0.00
CSF	Surface Water	Zinc	mg/l	3	100%	3	0.01	0.04	0.08	0.08
CSF	Surface Water	Calcium	mg/l	3	100%	3	52.00	52.67	53.00	53.00
CSF	Surface Water	Ortho-Phosphate-P	mg/l	3	100%	3	0.06	0.08	0.12	0.12
CSF	Surface Water	Fluoride	mg/l	3	100%	3	0.24	0.25	0.27	0.27
CSF	Surface Water	Hardness as CaCO3	mg/l	3	100%	3	260.00	263.33	270.00	270.00
CSF	Surface Water	Total Phosphorus	mg/l	3	100%	3	0.13	0.15	0.18	0.18
CSF	Surface Water	pH	su	3	100%	3	7.40	7.87	8.60	8.60
CSF	Surface Water	Suspended Solids	mg/l	3	67%	3	2.50	7.50	12.00	12.00
CSF	Surface Water	Total Dissolved Solids	mg/l	3	100%	3	330.00	348.67	360.00	360.00
CSF	Surface Water	Fluoranthene	ug/l	3	33%	1	0.70	0.70	0.70	0.70
CSF	Surface Water	Phenanthrene	ug/l	3	33%	1	0.70	0.70	0.70	0.70
CSF	Surface Water	Benzene	ug/l	3	33%	3	0.60	0.87	1.70	1.70

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

Table 4-29  
Surface-Water Sampling Summary - Site M

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
M	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	Aluminum	mg/l	1	100%	1	0.08	0.08	0.08	0.08
M	Surface Water	Iron	mg/l	1	100%	1	1.90	1.90	1.90	1.90
M	Surface Water	Lead	mg/l	1	100%	1	0.01	0.01	0.01	0.01
M	Surface Water	Magnesium	mg/l	1	100%	1	4.80	4.80	4.80	4.80
M	Surface Water	Manganese	mg/l	1	100%	1	0.17	0.17	0.17	0.17
M	Surface Water	Molybdenum	mg/l	1	100%	1	0.01	0.01	0.01	0.01
M	Surface Water	Nickel	mg/l	1	100%	1	0.01	0.01	0.01	0.01
M	Surface Water	Potassium	mg/l	1	100%	1	4.20	4.20	4.20	4.20
M	Surface Water	Sodium	mg/l	1	100%	1	27.00	27.00	27.00	27.00
M	Surface Water	Barium	mg/l	1	100%	1	0.21	0.21	0.21	0.21
M	Surface Water	Copper	mg/l	1	100%	1	0.05	0.05	0.05	0.05
M	Surface Water	Zinc	mg/l	1	100%	1	0.03	0.03	0.03	0.03
M	Surface Water	Calcium	mg/l	1	100%	1	48.00	48.00	48.00	48.00
M	Surface Water	Ortho-Phosphate-P	mg/l	1	100%	1	0.18	0.18	0.18	0.18
M	Surface Water	Fluoride	mg/l	1	100%	1	0.22	0.22	0.22	0.22
M	Surface Water	Hardness as CaCO3	mg/l	1	100%	1	140.00	140.00	140.00	140.00
M	Surface Water	Total Phosphorus	mg/l	1	100%	1	0.32	0.32	0.32	0.32
M	Surface Water	pH (7.1.4.2) *	su	1	100%	1	7.30	7.30	7.30	7.30
M	Surface Water	Suspended Solids	mg/l	1	100%	1	9.00	9.00	9.00	9.00
M	Surface Water	Total Dissolved Solids	mg/l	1	100%	1	270.00	270.00	270.00	270.00
M	Surface Water	Heptachlor epoxide	ug/l	1	100%	1	0.01	0.01	0.01	0.01
M	Surface Water	Aldrin	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	alpha-BHC	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	beta-BHC	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	delta-BHC	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	gamma-BHC (Lindane)	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	4,4'-DDE	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	Endrin aldehyde	ug/l	1	100%	1	0.00	0.00	0.00	0.00
M	Surface Water	Heptachlor	ug/l	1	100%	1	0.00	0.00	0.00	0.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum of the 95% UCL.

**Table 4-30**  
**Surface Water Sampling Summary - Old Prairie du Pont Creek**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
PDC	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	2	100%	2	0.00	0.00	0.00	0.00
PDC	Surface Water	Aluminum	mg/l	2	100%	2	1.65	2.13	2.60	2.60
PDC	Surface Water	Iron	mg/l	2	100%	2	2.65	3.33	4.00	4.00
PDC	Surface Water	Lead	mg/l	2	50%	1	0.00	0.00	0.00	0.00
PDC	Surface Water	Magnesium	mg/l	2	100%	2	40.00	40.00	40.00	40.00
PDC	Surface Water	Manganese	mg/l	2	100%	2	0.58	0.60	0.63	0.63
PDC	Surface Water	Molybdenum	mg/l	2	100%	2	0.00	0.00	0.00	0.00
PDC	Surface Water	Nickel	mg/l	2	50%	1	0.01	0.01	0.01	0.01
PDC	Surface Water	Potassium	mg/l	2	100%	2	7.50	7.50	7.50	7.50
PDC	Surface Water	Sodium	mg/l	2	100%	2	79.00	124.50	170.00	170.00
PDC	Surface Water	Arsenic	mg/l	2	50%	2	0.01	0.01	0.01	0.01
PDC	Surface Water	Barium	mg/l	2	100%	2	0.17	0.18	0.18	0.18
PDC	Surface Water	Cobalt	mg/l	2	100%	2	0.00	0.00	0.00	0.00
PDC	Surface Water	Zinc	mg/l	2	100%	2	0.02	0.02	0.02	0.02
PDC	Surface Water	Calcium	mg/l	2	100%	2	99.00	99.50	100.00	100.00
PDC	Surface Water	Ortho-Phosphate-P	mg/l	2	100%	2	0.46	0.53	0.60	0.60
PDC	Surface Water	Fluoride	mg/l	2	100%	2	0.38	0.41	0.44	0.44
PDC	Surface Water	Hardness as CaCO3	mg/l	2	100%	2	415.00	417.50	420.00	420.00
PDC	Surface Water	Total Phosphorus	mg/l	2	100%	2	0.63	0.78	0.83	0.83
PDC	Surface Water	pH	su	2	100%	2	7.70	7.78	7.85	7.85
PDC	Surface Water	Suspended Solids	mg/l	2	100%	2	56.00	488.00	920.00	920.00
PDC	Surface Water	Total Dissolved Solids	mg/l	2	100%	2	670.00	677.50	685.00	685.00
PDC	Surface Water	bis(2-Ethylhexyl)phthalate	ug/l	2	100%	2	0.51	0.68	0.84	0.84
PDC	Surface Water	Di-n-octylphthalate	ug/l	2	50%	1	1.10	1.10	1.10	1.10
PDC	Surface Water	Benzo(b)fluoranthene	ug/l	2	100%	2	0.95	1.89	2.83	2.83
PDC	Surface Water	Benzo(k)fluoranthene	ug/l	2	100%	2	1.70	2.29	2.88	2.88
PDC	Surface Water	Chrysene	ug/l	2	50%	1	0.74	0.74	0.74	0.74
PDC	Surface Water	Benzo(a)pyrene	ug/l	2	100%	2	1.10	1.99	2.89	2.89
PDC	Surface Water	Dibenzo(a,h)anthracene	ug/l	2	100%	2	1.20	2.05	2.91	2.91
PDC	Surface Water	Benzo(a)anthracene	ug/l	2	50%	1	0.62	0.62	0.62	0.62
PDC	Surface Water	Di-n-butylphthalate	ug/l	2	100%	2	0.30	1.48	2.65	2.65
PDC	Surface Water	Benzene	ug/l	2	50%	1	0.45	0.45	0.45	0.45

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.



Table 4-31 (1 or 2)  
Surface-Water Sampling Summary - Reference Areas

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			
							Minimum	Mean	Maximum	Site Concentration
RA	Surface Water	1998 Total TEQ w/ EMPC as ND	ug/l	4	100%	4	0.00	0.00	0.00	0.00
RA	Surface Water	Aluminum	mg/l	4	100%	4	8.40	13.23	19.50	19.50
RA	Surface Water	Iron	mg/l	4	100%	4	11.00	18.38	25.50	25.50
RA	Surface Water	Lead	mg/l	4	100%	4	0.02	0.03	0.03	0.03
RA	Surface Water	Magnesium	mg/l	4	100%	4	23.00	26.75	35.00	35.00
RA	Surface Water	Manganese	mg/l	4	100%	4	1.50	1.98	2.90	2.90
RA	Surface Water	Molybdenum	mg/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	Nickel	mg/l	4	100%	4	0.01	0.02	0.02	0.02
RA	Surface Water	Potassium	mg/l	4	100%	4	7.00	8.50	11.00	11.00
RA	Surface Water	Sodium	mg/l	4	100%	4	16.00	19.00	23.00	23.00
RA	Surface Water	Arsenic	mg/l	4	100%	4	0.01	0.01	0.02	0.02
RA	Surface Water	Barium	mg/l	4	100%	4	0.32	0.36	0.41	0.41
RA	Surface Water	Beryllium	mg/l	4	50%	2	0.00	0.00	0.00	0.00
RA	Surface Water	Chromium	mg/l	4	100%	4	0.01	0.02	0.02	0.02
RA	Surface Water	Cobalt	mg/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	Copper	mg/l	4	100%	4	0.01	0.01	0.02	0.02
RA	Surface Water	Vanadium	mg/l	4	100%	4	0.03	0.04	0.05	0.05
RA	Surface Water	Zinc	mg/l	4	100%	4	0.04	0.08	0.13	0.13
RA	Surface Water	Calcium	mg/l	4	100%	4	50.00	58.63	72.00	72.00
RA	Surface Water	Ortho-Phosphate-P	mg/l	4	75%	4	0.03	0.12	0.22	0.21
RA	Surface Water	Fluoride	mg/l	4	100%	4	0.23	0.31	0.38	0.38
RA	Surface Water	Hardness as CaCO3	mg/l	4	100%	4	220.00	256.25	330.00	330.00
RA	Surface Water	Total Phosphorus	mg/l	4	100%	4	0.87	1.84	3.00	3.00
RA	Surface Water	pH	su	4	100%	4	7.30	7.83	8.10	8.10
RA	Surface Water	Suspended Solids	mg/l	4	100%	4	270.00	420.00	700.00	700.00
RA	Surface Water	Total Dissolved Solids	mg/l	4	100%	4	310.00	387.50	460.00	460.00
RA	Surface Water	Heptachlor epoxide	ug/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	Endosulfan sulfate	ug/l	4	75%	3	0.00	0.00	0.01	0.01
RA	Surface Water	Aldrin	ug/l	4	50%	2	0.00	0.00	0.00	0.00
RA	Surface Water	alpha-BHC	ug/l	4	25%	1	0.00	0.00	0.00	0.00
RA	Surface Water	beta-BHC	ug/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	delta-BHC	ug/l	4	25%	4	0.01	0.01	0.01	0.01
RA	Surface Water	Endosulfan II	ug/l	4	25%	1	0.00	0.00	0.00	0.00
RA	Surface Water	4,4'-DDT	ug/l	4	25%	1	0.01	0.01	0.01	0.01
RA	Surface Water	Alpha Chlordane	ug/l	4	50%	2	0.00	0.01	0.01	0.01
RA	Surface Water	Gamma Chlordane	ug/l	4	50%	2	0.00	0.00	0.00	0.00

**Table 4-31 (c of 2)**  
**Surface-Water Sampling Summary - Reference Areas**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
RA	Surface Water	Endrin ketone	ug/l	4	50%	2	0.00	0.01	0.01	0.01
RA	Surface Water	gamma-BHC (Lindane)	ug/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	Dieldrin	ug/l	4	50%	2	0.00	0.00	0.00	0.00
RA	Surface Water	Endrin	ug/l	4	50%	2	0.00	0.00	0.01	0.01
RA	Surface Water	4,4'-DDE	ug/l	4	25%	1	0.00	0.00	0.00	0.00
RA	Surface Water	Endrin aldehyde	ug/l	4	25%	1	0.03	0.03	0.03	0.03
RA	Surface Water	Heptachlor	ug/l	4	25%	1	0.00	0.00	0.00	0.00
RA	Surface Water	Endosulfan I	ug/l	4	100%	4	0.00	0.01	0.01	0.01
RA	Surface Water	3,3'-Dichlorobenzidine	ug/l	4	25%	1	5.00	5.00	5.00	5.00
RA	Surface Water	Acetone	ug/l	4	25%	4	25.00	25.13	25.50	25.42

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-32  
Air Sampling Summary - Upwind

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Upwind	Air	1998 Total TEQ w/ EMPC as ND	pg/m3	5	100%	5	0.01	0.02	0.03	0.03
Upwind	Air	Aluminum	mg/m3	5	20%	5	0.00	0.00	0.00	0.00
Upwind	Air	Iron	mg/m3	5	20%	5	0.00	0.00	0.00	0.00
Upwind	Air	Lead	mg/m3	5	100%	5	0.00	0.00	0.00	0.00
Upwind	Air	Magnesium	mg/m3	5	80%	4	0.00	0.00	0.00	0.00
Upwind	Air	Nickel	mg/m3	5	20%	1	0.00	0.00	0.00	0.00
Upwind	Air	Cadmium	mg/m3	5	60%	5	0.00	0.00	0.00	0.00
Upwind	Air	Copper	mg/m3	5	80%	5	0.00	0.00	0.00	0.00
Upwind	Air	Calcium	mg/m3	5	20%	5	0.02	0.02	0.03	0.03
Upwind	Air	Benzyl alcohol	ug/m3	5	60%	5	0.02	0.04	0.08	0.08
Upwind	Air	1,4-Dichlorobenzene	ug/m3	5	20%	5	0.02	0.03	0.06	0.06
Upwind	Air	Phenol	ug/m3	5	60%	5	0.02	0.05	0.07	0.07
Upwind	Air	bis(2-Ethylhexyl)phthalate	ug/m3	5	100%	5	0.03	0.04	0.05	0.05
Upwind	Air	Dimethylphthalate	ug/m3	5	80%	5	0.02	0.03	0.04	0.04
Upwind	Air	Dibenzofuran	ug/m3	5	60%	5	0.02	0.02	0.03	0.03
Upwind	Air	Acenaphthene	ug/m3	5	60%	5	0.02	0.03	0.05	0.05
Upwind	Air	Diethylphthalate	ug/m3	5	80%	5	0.02	0.03	0.04	0.04
Upwind	Air	Phenanthrene	ug/m3	5	60%	4	0.02	0.02	0.03	0.03
Upwind	Air	Fluorene	ug/m3	5	100%	5	0.09	0.12	0.15	0.15
Upwind	Air	2-Methylnaphthalene	ug/m3	5	80%	4	1.31	1.98	2.79	2.79
Upwind	Air	Ethylbenzene	ug/m3	5	80%	5	1.31	2.37	4.26	4.26
Upwind	Air	m&p-Xylene	ug/m3	5	20%	5	54.29	103.75	283.84	283.84
Upwind	Air	Acetone	ug/m3	5	40%	5	5.43	94.00	300.22	300.22
Upwind	Air	Methylene chloride (Dichloromethane)	ug/m3	5	20%	5	5.45	11.22	32.57	32.57
Upwind	Air	1,1-Dichloroethene	ug/m3	5	20%	1	24.02	24.02	24.02	24.02
Upwind	Air	2-Butanone (MEK)	ug/m3	5	20%	1	4.80	4.80	4.80	4.80
Upwind	Air	Trichloroethene	ug/m3	5	60%	3	1.31	2.30	3.46	3.46
Upwind	Air	o-Xylene	ug/m3	5	40%	2	1.42	1.54	1.67	1.67
Upwind	Air	Isopropylbenzene	ug/m3	5						

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-33  
Air Sampling Summary - Downwind

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Downwind	Air	1998 Total TEQ w/ EMPC as ND	pg/m3	8	100%	8	0.01	0.03	0.04	0.04
Downwind	Air	Lead	mg/m3	8	100%	8	0.00	0.00	0.00	0.00
Downwind	Air	Magnesium	mg/m3	8	100%	8	0.00	0.00	0.00	0.00
Downwind	Air	Manganese	mg/m3	8	38%	8	0.00	0.00	0.00	0.00
Downwind	Air	Silver	mg/m3	8	13%	8	0.00	0.00	0.00	0.00
Downwind	Air	Sodium	mg/m3	8	38%	3	0.00	0.00	0.00	0.00
Downwind	Air	Cadmium	mg/m3	8	63%	8	0.00	0.00	0.00	0.00
Downwind	Air	Copper	mg/m3	8	63%	8	0.00	0.00	0.00	0.00
Downwind	Air	Calcium	mg/m3	8	50%	8	0.00	0.00	0.00	0.00
Downwind	Air	1,4-Dichlorobenzene	ug/m3	8	75%	8	0.02	0.11	0.42	0.42
Downwind	Air	bis(2-Ethylhexyl)phthalate	ug/m3	8	63%	8	0.01	0.05	0.08	0.07
Downwind	Air	Dimethylphthalate	ug/m3	8	100%	8	0.03	0.04	0.07	0.06
Downwind	Air	Dibenzofuran	ug/m3	8	100%	8	0.02	0.03	0.04	0.04
Downwind	Air	Acenaphthene	ug/m3	8	100%	8	0.02	0.03	0.04	0.03
Downwind	Air	Diethylphthalate	ug/m3	8	25%	8	0.01	0.02	0.03	0.02
Downwind	Air	Phenanthrene	ug/m3	8	88%	8	0.02	0.03	0.06	0.05
Downwind	Air	Fluorene	ug/m3	8	100%	8	0.02	0.02	0.03	0.03
Downwind	Air	2-Nitroaniline	ug/m3	8	13%	1	0.03	0.03	0.03	0.03
Downwind	Air	2-Methylnaphthalene	ug/m3	8	100%	8	0.09	0.12	0.15	0.13
Downwind	Air	1,2-Dichlorobenzene	ug/m3	8	25%	8	0.01	0.05	0.26	0.22
Downwind	Air	Ethylbenzene	ug/m3	8	50%	8	1.45	5.64	17.70	16.67
Downwind	Air	Styrene	ug/m3	8	13%	8	3.25	7.48	20.35	12.84
Downwind	Air	n-Butylbenzene	ug/m3	8	13%	1	1.45	1.45	1.45	1.45
Downwind	Air	4-Methyl-2-pentanone (MIBK)	ug/m3	8	13%	8	32.47	62.60	106.19	78.66
Downwind	Air	m&p-Xylene	ug/m3	8	50%	8	0.58	6.50	19.47	19.47
Downwind	Air	Toluene	ug/m3	8	13%	8	4.79	27.55	166.81	112.13
Downwind	Air	Tetrachloroethene	ug/m3	8	25%	2	0.91	1.91	2.92	2.92
Downwind	Air	s-Butylbenzene	ug/m3	8	13%	1	2.21	2.21	2.21	2.21
Downwind	Air	Acetone	ug/m3	8	25%	8	24.03	143.40	761.08	486.68
Downwind	Air	1,1,1-Trichloroethane	ug/m3	8	13%	8	3.25	6.28	11.87	9.28
Downwind	Air	Methylene chloride (Dichloromethane)	ug/m3	8	75%	8	5.49	69.17	2424.43	2424.43
Downwind	Air	1,1-Dichloroethene	ug/m3	8	13%	8	3.25	8.23	27.47	18.08
Downwind	Air	2-Butanone (MEK)	ug/m3	8	38%	3	18.81	24.00	30.53	30.53
Downwind	Air	Trichloroethene	ug/m3	8	13%	6	3.42	5.36	6.69	6.37
Downwind	Air	o-Xylene	ug/m3	8	50%	8	1.83	6.15	17.70	13.79
Downwind	Air	i-Butylbenzene	ug/m3	8	25%	8	0.71	5.79	9.38	7.59
Downwind	Air	Isopropylbenzene	ug/m3	8	25%	8	2.34	7.58	22.12	14.88
Downwind	Air	p-Isopropyltoluene	ug/m3	8	13%	8	3.25	6.04	8.65	7.37

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-34  
Biota - Bottom Feeder Fish

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics		
							Minimum	Mean	Maximum
Bottom Feeder Fish	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	6	100%	6	0.00	0.00	0.00
Bottom Feeder Fish	Biota	Dichloroprop	ug/kg	6	17%	1	6.60	6.60	6.60
Bottom Feeder Fish	Biota	MCPA[(4-chloro-2-methylphenoxy)-acetic a	ug/kg	6	17%	6	1000.00	2286.67	8600.00
Bottom Feeder Fish	Biota	Aluminum	mg/kg	6	100%	6	5.90	23.43	66.00
Bottom Feeder Fish	Biota	Lead	mg/kg	6	50%	6	0.18	0.23	0.25
Bottom Feeder Fish	Biota	Mercury	mg/kg	6	100%	6	0.05	0.10	0.26
Bottom Feeder Fish	Biota	Chromium	mg/kg	6	100%	6	0.27	0.41	0.70
Bottom Feeder Fish	Biota	Copper	mg/kg	6	100%	6	0.79	0.98	1.10
Bottom Feeder Fish	Biota	Zinc	mg/kg	6	100%	6	18.00	19.83	24.00
Bottom Feeder Fish	Biota	Selenium	mg/kg	6	33%	6	0.23	0.32	0.50
Bottom Feeder Fish	Biota	% Lipids	%	6	100%	6	0.30	1.13	1.70
Bottom Feeder Fish	Biota	Alpha Chlordane	ug/kg	6	67%	6	1.10	4.52	12.00
Bottom Feeder Fish	Biota	Gamma Chlordane	ug/kg	6	50%	6	3.40	6.78	11.00
Bottom Feeder Fish	Biota	gamma-BHC (Lindane)	ug/kg	6	33%	2	0.94	1.07	1.20
Bottom Feeder Fish	Biota	Dieldrin	ug/kg	6	50%	3	1.70	2.77	3.80
Bottom Feeder Fish	Biota	Endrin	ug/kg	6	17%	1	2.60	2.60	2.60
Bottom Feeder Fish	Biota	4,4'-DDD	ug/kg	6	33%	2	1.20	1.50	1.80
Bottom Feeder Fish	Biota	4,4'-DDE	ug/kg	6	100%	6	3.40	13.32	29.00
Bottom Feeder Fish	Biota	Heptachlor	ug/kg	6	17%	1	2.80	2.80	2.80
Bottom Feeder Fish	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	6	50%	6	48.00	74.17	97.00
Bottom Feeder Fish	Biota	Diethylphthalate	ug/kg	6	33%	2	18.00	21.50	25.00
Bottom Feeder Fish	Biota	Total PCBs	ug/kg	6	33%	6	25.00	46.67	104.00
Bottom Feeder Fish	Biota								75.22

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration

Table 4-35  
Biota - Forage Fish

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Forage Fish	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	7	100%	7	0.00	0.00	0.00	0.00
Forage Fish	Biota	Dichloroprop	ug/kg	7	29%	2	5.10	5.90	6.70	6.70
Forage Fish	Biota	Dicamba	ug/kg	7	14%	1	2.60	2.60	2.60	2.60
Forage Fish	Biota	MCPA[(4-chloro-2-methylphenoxy)-acetic a	ug/kg	7	43%	7	1000.00	1971.43	3300.00	2709.20
Forage Fish	Biota	2,4-DB	ug/kg	7	43%	7	5.00	7.36	10.00	10.00
Forage Fish	Biota	Aluminum	mg/kg	7	100%	7	13.00	47.86	100.00	100.00
Forage Fish	Biota	Lead	mg/kg	7	43%	7	0.23	0.34	0.59	0.50
Forage Fish	Biota	Mercury	mg/kg	7	86%	7	0.02	0.13	0.60	0.60
Forage Fish	Biota	Chromium	mg/kg	7	100%	7	0.24	0.34	0.47	0.43
Forage Fish	Biota	Copper	mg/kg	7	100%	7	0.42	0.87	1.70	1.61
Forage Fish	Biota	Zinc	mg/kg	7	100%	7	17.00	31.29	53.00	43.16
Forage Fish	Biota	Selenium	mg/kg	7	71%	7	0.23	0.48	0.65	0.66
Forage Fish	Biota	% Lipids	%	7	100%	7	1.00	1.56	2.60	2.06
Forage Fish	Biota	Total PCBs	ug/kg	7	43%	7	19.00	201.67	1167.00	1167.00
Forage Fish	Biota	Gamma Chlordane	ug/kg	7	14%	1	1.20	1.20	1.20	1.20
Forage Fish	Biota	Dieldrin	ug/kg	7	26%	2	1.60	3.15	4.70	4.70
Forage Fish	Biota	4,4'-DDE	ug/kg	7	71%	7	1.30	6.36	10.00	8.92
Forage Fish	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	8	75%	8	99.00	174.88	280.00	227.07
Forage Fish	Biota	Indeno(1,2,3-cd)pyrene	ug/kg	8	13%	1	54.00	54.00	54.00	54.00
Forage Fish	Biota	Dibenzo(a,h)anthracene	ug/kg	8	25%	2	22.00	35.00	48.00	48.00
Forage Fish	Biota	Diethylphthalate	ug/kg	8	88%	7	18.00	35.00	93.00	66.01
Forage Fish	Biota	Pentachlorophenol	ug/kg	7	71%	6	106.10	141.34	210.75	206.49

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-36  
Biota - Predator Fish

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Predator Fish	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	7	100%	7	0.00	0.00	0.00	0.00
Predator Fish	Biota	Dicamba	ug/kg	7	14%	1	1.90	1.90	1.90	1.90
Predator Fish	Biota	MCPA[(4-chloro-2-methylphenoxy)-acetic a	ug/kg	7	14%	7	1000.00	1114.29	1800.00	1336.36
Predator Fish	Biota	Aluminum	mg/kg	7	86%	7	6.50	31.93	81.00	81.00
Predator Fish	Biota	Mercury	mg/kg	7	86%	7	0.01	0.08	0.14	0.11
Predator Fish	Biota	Chromium	mg/kg	7	100%	7	0.19	0.44	0.93	0.78
Predator Fish	Biota	Copper	mg/kg	7	100%	7	0.36	0.53	0.84	0.69
Predator Fish	Biota	Zinc	mg/kg	7	100%	7	8.50	13.81	19.00	16.68
Predator Fish	Biota	Selenium	mg/kg	7	71%	7	0.23	0.55	0.86	0.72
Predator Fish	Biota	% Lipids	%	7	100%	7	0.66	1.37	2.40	2.21
Predator Fish	Biota	Total PCBs	ug/kg	7	57%	7	18.80	111.40	320.00	320.00
Predator Fish	Biota	Gamma Chlordane	ug/kg	7	29%	7	1.35	6.99	19.00	19.00
Predator Fish	Biota	Dieldrin	ug/kg	7	28%	3	2.65	4.52	5.60	5.60
Predator Fish	Biota	4,4'-DDE	ug/kg	7	86%	7	3.50	9.10	21.00	18.55
Predator Fish	Biota	Heptachlor	ug/kg	7	14%	2	1.35	1.43	1.50	1.50
Predator Fish	Biota	Di-n-butylphthalate	ug/kg	7	43%	3	19.00	23.67	32.00	32.00
Predator Fish	Biota	Total PCBs	ug/kg	7	57%	7	18.80	111.40	320.00	320.00

Table 4-37  
Biota - Fish Fillets

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Fish Fillets	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	7	100%	7	0.00	0.00	0.02	0.02
Fish Fillets	Biota	Mercury	mg/kg	6	67%	6	0.01	0.04	0.05	0.05
Fish Fillets	Biota	Arsenic	mg/kg	6	17%	1	0.45	0.45	0.45	0.45
Fish Fillets	Biota	Chromium	mg/kg	6	33%	4	0.21	0.21	0.22	0.22
Fish Fillets	Biota	Copper	mg/kg	6	67%	4	0.23	0.34	0.57	0.57
Fish Fillets	Biota	Zinc	mg/kg	6	100%	6	6.40	7.45	9.20	8.35
Fish Fillets	Biota	Selenium	mg/kg	6	17%	6	0.21	0.30	0.73	0.55
Fish Fillets	Biota	% Lipids	%	8	100%	8	0.15	0.45	1.50	1.16
Fish Fillets	Biota	Gamma Chlordane	ug/kg	2	50%	3	1.00	3.03	4.70	4.70
Fish Fillets	Biota	4,4'-DDE	ug/kg	2	50%	3	2.00	5.90	9.20	9.20
Fish Fillets	Biota	Heptachlor	ug/kg	5	60%	4	1.00	1.30	1.80	1.80
Fish Fillets	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	6	83%	6	64.00	89.00	130.00	114.59
Fish Fillets	Biota	Di-n-butylphthalate	ug/kg	6	17%	1	27.00	27.00	27.00	27.00
Fish Fillets	Biota	Pentachlorophenol	ug/kg	7	43%	3	5.00	38.97	108.90	108.90



Table 4-38  
Biota - Clams

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			
							Minimum	Mean	Maximum	Site Concentration
Clams	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	6	100%	6	0.00	0.00	0.00	0.00
Clams	Biota	Dichloroprop	ug/kg	6	100%	6	3.20	26.45	87.00	87.00
Clams	Biota	MCPPI[2-(4-chloro-2-methylphenoxy)-propan	ug/kg	6	17%	4	1000.00	1750.00	4000.00	4000.00
Clams	Biota	MCPA[(4-chloro-2-methylphenoxy)-acetic a	ug/kg	6	17%	3	1000.00	1133.33	1400.00	1400.00
Clams	Biota	Aluminum	mg/kg	6	100%	6	7.50	14.42	26.00	22.95
Clams	Biota	Lead	mg/kg	6	50%	6	0.23	0.33	0.59	0.53
Clams	Biota	Silver	mg/kg	6	17%	1	0.02	0.02	0.02	0.02
Clams	Biota	Arsenic	mg/kg	6	33%	2	0.65	0.81	0.86	0.86
Clams	Biota	Cadmium	mg/kg	6	83%	6	0.07	0.28	0.61	0.61
Clams	Biota	Chromium	mg/kg	6	100%	6	0.22	1.09	2.20	1.86
Clams	Biota	Copper	mg/kg	6	100%	6	0.80	1.50	2.40	2.40
Clams	Biota	Zinc	mg/kg	6	100%	6	8.80	26.48	52.00	52.00
Clams	Biota	Selenium	mg/kg	6	17%	6	0.23	0.27	0.48	0.37
Clams	Biota	% Lipids	%	6	100%	6	0.05	0.12	0.23	0.22
Clams	Biota	Methoxychlor	ug/kg	6	17%	1	5.40	5.40	5.40	5.40
Clams	Biota	Heptachlor	ug/kg	6	17%	3	1.35	1.67	2.30	2.30
Clams	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	6	100%	6	47.00	80.87	170.00	135.54
Clams	Biota	Diethylphthalate	ug/kg	6	100%	6	49.00	64.33	120.00	91.78

Table 4-39  
Biota - Snails

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Snails	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	5	100%	5	0.00	0.02	0.08	0.06
Snails	Biota	Dicamba	ug/kg	5	20%	1	8.40	8.40	8.40	8.40
Snails	Biota	MCPP[2-(4-chloro-2-methylphenoxy)-propan	ug/kg	5	40%	5	1000.00	1780.00	3300.00	2825.26
Snails	Biota	2,4,5-TP (Silvex)	ug/kg	5	20%	5	5.00	5.26	6.30	5.81
Snails	Biota	MCPA[4-chloro-2-methylphenoxy)-acetic a	ug/kg	5	20%	5	1000.00	2080.00	8400.00	4382.39
Snails	Biota	Aluminum	mg/kg	5	100%	5	320.00	504.00	710.00	710.00
Snails	Biota	Lead	mg/kg	5	100%	5	2.30	5.22	11.00	11.00
Snails	Biota	Nickel	mg/kg	5	100%	5	1.70	7.52	21.00	21.00
Snails	Biota	Silver	mg/kg	5	100%	5	0.02	0.05	0.07	0.07
Snails	Biota	Antimony	mg/kg	5	20%	5	0.08	0.10	0.12	0.11
Snails	Biota	Arsenic	mg/kg	5	100%	5	1.50	1.70	2.00	1.82
Snails	Biota	Cadmium	mg/kg	5	80%	5	0.07	0.34	0.67	0.67
Snails	Biota	Chromium	mg/kg	5	100%	5	0.89	1.86	3.10	3.10
Snails	Biota	Copper	mg/kg	5	100%	5	10.00	49.20	120.00	120.00
Snails	Biota	Zinc	mg/kg	5	100%	5	12.00	48.00	110.00	110.00
Snails	Biota	Selenium	mg/kg	5	20%	5	0.21	0.28	0.49	0.44
Snails	Biota	% Lipids	%	5	100%	5	0.09	0.16	0.26	0.26
Snails	Biota	Heptachlor epoxide	ug/kg	5	40%	5	1.35	20.08	66.00	66.00
Snails	Biota	Endosulfan sulfate	ug/kg	5	20%	2	2.65	3.18	3.70	3.70
Snails	Biota	Gamma Chlordane	ug/kg	5	60%	5	1.35	15.18	41.00	41.00
Snails	Biota	Endrin ketone	ug/kg	5	20%	3	2.65	4.57	7.10	7.10
Snails	Biota	4,4'-DDE	ug/kg	5	40%	5	2.65	15.72	30.00	30.00
Snails	Biota	3,4-Methylphenol (m&p-cresol)	ug/kg	5	60%	5	63.00	1714.60	8200.00	8200.00
Snails	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	5	100%	5	78.00	133.00	230.00	230.00
Snails	Biota	Benzo(b)fluoranthene	ug/kg	5	20%	1	79.00	79.00	79.00	79.00
Snails	Biota	Chrysene	ug/kg	5	20%	1	34.00	34.00	34.00	34.00
Snails	Biota	Benzo(e)pyrene	ug/kg	5	20%	1	31.00	31.00	31.00	31.00
Snails	Biota	Diethylphthalate	ug/kg	5	100%	5	54.00	58.80	63.00	63.00
Snails	Biota	Pentachlorophenol	ug/kg	5	60%	5	105.55	130.19	217.50	181.13
Snails	Biota	Total PCBs	ug/kg	5	60%	5	25.00	211.80	471.00	471.00

**Table 4-40**  
**Biota - Shrimp**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Shrimp	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	3	100%	3	0.00	0.00	0.00	0.00
Shrimp	Biota	MCPPI[2-(4-chloro-2-methylphenoxy) propan	ug/kg	3	33%	3	1000.00	2133.33	4400.00	4400.00
Shrimp	Biota	2,4,5-TP (Silvex)	ug/kg	3	33%	1	1.30	1.30	1.30	1.30
Shrimp	Biota	Aluminum	mg/kg	3	100%	3	28.00	62.67	100.00	100.00
Shrimp	Biota	Lead	mg/kg	3	100%	3	0.38	0.46	0.61	0.61
Shrimp	Biota	Silver	mg/kg	3	100%	3	0.06	0.07	0.09	0.09
Shrimp	Biota	Antimony	mg/kg	3	33%	3	0.08	0.11	0.16	0.16
Shrimp	Biota	Arsenic	mg/kg	3	33%	3	1.00	1.07	1.20	1.20
Shrimp	Biota	Chromium	mg/kg	3	100%	3	0.23	0.26	0.28	0.28
Shrimp	Biota	Copper	mg/kg	3	100%	3	8.30	10.93	16.00	16.00
Shrimp	Biota	Zinc	mg/kg	3	100%	3	15.00	16.00	17.00	17.00
Shrimp	Biota	Selenium	mg/kg	3	67%	3	0.25	0.44	0.61	0.61
Shrimp	Biota	% Lipids	%	3	100%	3	0.03	0.23	0.36	0.36
Shrimp	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	3	67%	2	92.00	95.00	98.00	98.00
Shrimp	Biota	Diethylphthalate	ug/kg	3	100%	3	44.00	53.33	59.00	59.00
Shrimp	Biota	Pentachlorophenol	ug/kg	3	100%	3	210.75	211.20	211.95	211.95
Shrimp	Biota	Total PCBs	ug/kg	3	33%	1	22.00	22.00	22.00	22.00

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

**Table 4-41 (1 of 2)**  
**Biota - Plants**

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Plant	Biota	1998 Total TEQ w/ EMPC as ND	ug/kg	15	100%	15	0.00	0.03	0.18	0.18
Plant	Biota	Dichloroprop	ug/kg	15	7%	1	7.00	7.00	7.00	7.00
Plant	Biota	Dicamba	ug/kg	15	13%	2	1.80	3.05	4.30	4.30
Plant	Biota	MCPPI2-(4-chloro-2-methylphenoxy)-propan	ug/kg	15	40%	15	400.00	1038.67	1800.00	1175.84
Plant	Biota	2,4,5-T	ug/kg	15	7%	1	1.10	1.10	1.10	1.10
Plant	Biota	Aluminum	mg/kg	15	100%	15	17.00	288.60	1400.00	917.46
Plant	Biota	Lead	mg/kg	15	100%	15	0.30	10.07	78.00	44.16
Plant	Biota	Mercury	mg/kg	15	33%	15	0.00	0.01	0.03	0.01
Plant	Biota	Nickel	mg/kg	15	73%	15	1.20	15.55	110.00	35.53
Plant	Biota	Silver	mg/kg	15	40%	15	0.02	0.08	0.50	0.12
Plant	Biota	Antimony	mg/kg	15	47%	15	0.09	0.23	1.20	0.34
Plant	Biota	Arsenic	mg/kg	15	53%	15	0.25	0.87	4.30	1.28
Plant	Biota	Beryllium	mg/kg	15	7%	1	0.14	0.14	0.14	0.14
Plant	Biota	Cadmium	mg/kg	15	60%	15	0.08	0.88	5.30	2.20
Plant	Biota	Chromium	mg/kg	15	73%	15	0.17	1.50	9.00	3.71
Plant	Biota	Copper	mg/kg	15	100%	15	0.85	53.69	390.00	390.00
Plant	Biota	Zinc	mg/kg	15	100%	15	6.80	108.41	610.00	288.62
Plant	Biota	Heptachlor epoxide	ug/kg	15	33%	15	2.50	7.28	15.00	8.98
Plant	Biota	Aldrin	ug/kg	15	53%	15	0.81	5.52	12.00	7.02
Plant	Biota	4,4'-DDT	ug/kg	15	13%	2	2.90	8.95	11.00	11.00
Plant	Biota	Gamma Chlordane	ug/kg	15	40%	15	2.10	8.10	10.00	7.21
Plant	Biota	Methoxychlor	ug/kg	15	7%	1	28.00	28.00	28.00	28.00
Plant	Biota	4,4'-DDE	ug/kg	15	33%	15	1.20	11.35	20.00	13.97
Plant	Biota	Endrin aldehyde	ug/kg	15	13%	14	6.50	12.75	18.00	13.88
Plant	Biota	Heptachlor	ug/kg	15	27%	4	1.80	2.60	3.80	3.80
Plant	Biota	2,4-Dimethylphenol	ug/kg	15	13%	15	51.00	83.40	95.00	87.64
Plant	Biota	bis(2-Ethylhexyl)phthalate	ug/kg	15	27%	15	50.00	81.67	94.00	87.40
Plant	Biota	Pyrene	ug/kg	15	13%	2	22.00	25.50	29.00	29.00
Plant	Biota	Benzo(g,h,i)perylene	ug/kg	15	40%	15	38.00	157.47	500.00	246.90
Plant	Biota	Indeno(1,2,3-cd)pyrene	ug/kg	15	53%	15	23.00	149.60	520.00	283.55
Plant	Biota	Benzo(b)fluoranthene	ug/kg	15	33%	15	18.00	93.27	430.00	158.78
Plant	Biota	Fluoranthene	ug/kg	15	13%	2	25.00	28.50	32.00	32.00
Plant	Biota	Benzo(k)fluoranthene	ug/kg	15	40%	15	21.00	82.53	320.00	128.40
Plant	Biota	Acenaphthylene	ug/kg	15	13%	2	32.00	50.50	69.00	69.00
Plant	Biota	Chrysene	ug/kg	15	13%	2	22.00	23.50	25.00	25.00
Plant	Biota	Benzo(a)pyrene	ug/kg	15	40%	15	15.00	111.93	670.00	197.08

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration.

Table 4-41 (2 of 2)  
Biota - Plants

Area	Medium	Constituent	Units	Number of Samples Analyzed	Frequency of Detection	Number of Samples for Statistics	Summary Statistics			Site Concentration
							Minimum	Mean	Maximum	
Plant	Biota	Dibenzof(a,h)anthracene	ug/kg	15	40%	15	30.00	108.60	400.00	144.33
Plant	Biota	Diethylphthalate	ug/kg	15	13%	2	13.00	14.00	15.00	15.00
Plant	Biota	Di-n-butylphthalate	ug/kg	15	7%	1	14.00	14.00	14.00	14.00
Plant	Biota	Phenanthrene	ug/kg	15	13%	2	16.00	18.50	17.00	17.00
Plant	Biota	Pentachlorophenol	ug/kg	15	53%	15	105.60	108.70	113.00	108.71
Plant	Biota	Total PCBs	ug/kg	15	13%	15	25.00	36.87	123.00	47.32

NOTE: Site concentration is the lower of the 95% UCL or the maximum detected concentration